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ERRATUM

In the article by Rolf L. Bolin, in COPEIA, 1936 (3), p. 153, item *c* in the Artificial Key to the Known Species of *Icelinus* should read as follows:

c. Top of head marked by an abrupt depression; 2nd dorsal of 13 to 15 rays ..... 3. *cavifrons*

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The Growth of the Muskellunge, *Esox masquinongy immaculatus* (Garrard), in Various Lakes and Drainage Areas of Northern Wisconsin[1]

By Clarence L. Schloemer

THIS study of muskellunge growth is a continuation of the game fish studies undertaken by the Wisconsin Geological and Natural History Survey since 1928. In the summer of that year the late Dr. G. I. Kemmerer, in cooperation with the U. S. Bureau of Fisheries, interested a considerable number of Wisconsin anglers in research on the growth of game fish and obtained scales and data from the fish they captured. This cooperative enterprise has continued up to the present time with the result that a scale collection representing 3500 specimens of game fish is now at the disposal of fishery biologists at the University of Wisconsin. The willingness of anglers to cooperate in these studies is noteworthy and especially significant from the conservationist's viewpoint. The 8 years of cooperation between anglers and fishery investigators show that fishermen are deeply concerned over the preservation of their game stock.

Within 2 years after the inauguration of the program, sufficient data were on hand to make a study of the growth rates of the valuable game species. The first report appeared in the spring of 1930 (Juday and Schneberger, 1930). It stated the age–length relationships of 10 game species, based on an examination of the scales of 336 specimens taken by anglers and scales from 164 individuals collected by Bureau of Fisheries investigators during the 1927 and 1928 seasons at the Trout Lake Laboratory. Thirty-eight of the 500 individuals represented in the 1930 scale collection were muskellunge. Twenty-five of these had been caught by anglers and the remainder by investigators. All of the specimens taken by the latter measured below the legal length of 30 inches. The scales from these young individuals were of considerable value in the present study. Their conspicuous annuli gave the author a definite idea concerning their nature and made age determination of these scales a simple task. In the second place, the actual lengths of these specimens verified the calculated lengths, for the earlier years of life, made from the scales of the older individuals.

The rapid accumulation of data made possible a second report of game fish growth in 1933 (Juday and Schneberger, 1933). By this time the scale collection had increased to 1100, largely through the splendid cooperation of the fishermen. Their hearty response made it necessary to limit the number of species considered to the 5 most important, namely, the muskellunge, *Esox masquinongy immaculatus* (Garrard), northern pike, *Esox lucius* Linnaeus, wall-eyed pike or yellow pike-perch, *Stizostedion vitreum* (Mitchill), large-mouthed black bass, *Aplites salmoides* (Lacépède), and the small-mouthed black bass, *Micropterus dolomieu* (Lacépède).

[1] From the Limnological Laboratory of the Wisconsin Geological and Natural History Survey. Notes and reports No. 62.—Published under a grant from the American Wildlife Institute, for the publication of contributions fundamental to fish management.

A third report, appearing in 1935, presented data on 2720 individuals of the 5 species mentioned above, including 269 muskellunge. The large number of specimens for each of the 5 groups made it worth while to include the length–weight as well as the age–length relationships (Juday and Bennett, 1935).

The addition of data from 106 muskellunge taken during the 1935 season by anglers increased the total number of muskellunge represented in the scale collection to 375. Not all of these could be used in the present study, however, for some scales were regenerated and had to be discarded, while in several other samples, the annuli on the scale could not be distinguished. This study, therefore, is based on the scales and length data of 351 muskel-

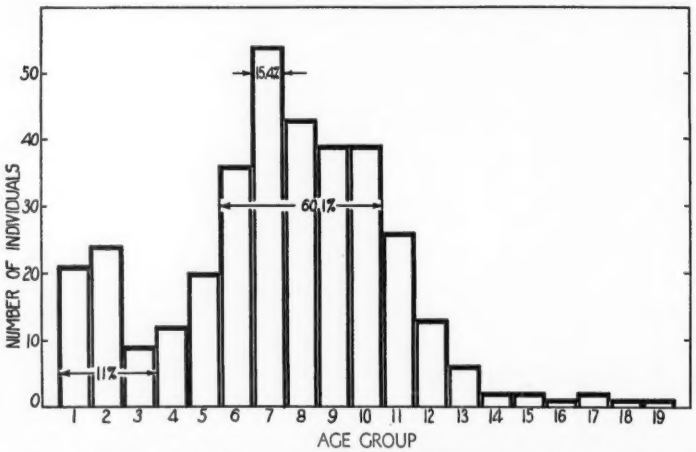

Fig. 1. Frequency distribution of the 351 muskellunge grouped into age groups.

lunge taken from 70 different Wisconsin lakes over an 8 year period. It differs from the aforementioned game fish growth reports in that each year's growth in length is calculated from scale measurements. Each calculation is based on the assumption that the length of the anterior radius of the muskellunge scale and the length of the fish maintain a constant ratio.

Distribution of Age Groups

The histogram represented in Fig. 1 shows the distribution of the 351 specimens when arranged in age groups. Age group VII (fish in their 8th summer) contained the largest number of individuals, or 15.4 per cent of the total number. Age groups VI to X included 60.1 per cent of the total number of muskellunge, or 67.6 per cent of the specimens caught by the anglers, indicating that the greatest returns are from these 5 age groups. Age groups IX and X were approximately equal in abundance. All of the individuals in the first 3 age groups are the undersized muskellunge captured by investigators during the summer work at the Trout Lake Laboratory.

The oldest muskellunge represented in the scale collection was in its 20th summer when taken. The longest specimen measured approximately 60

inches from the tip of the snout to the end of the caudal fin, while the heaviest muskellunge weighed 43.5 pounds. A muskellunge weighing 52 pounds and measuring 52 inches in length was taken from Sand Lake in Vilas County, Wisconsin, during the 1935 season.

Rate of Growth

The average rate of growth of the 351 muskellunge is shown in the upper curve of Fig. 2. The annual increase in standard length is represented by the increment curve in this figure. The upper curve shows that there is a rapid

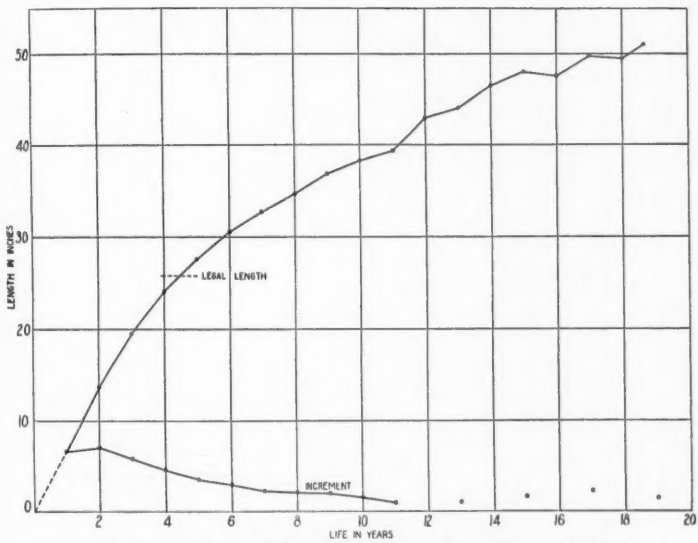

Fig. 2. Growth and increment curves of the 351 muskellunge.

The increment curve was not extended beyond the 11th year because of the few specimens available in the older age groups. The standard length is indicated in this and the following figures; the legal size limit in total length is 30 inches.

increase in length during the first 3 years, after which the growth is somewhat slower. This decrease in annual increment is correlated with a more rapid increase in weight. After the 11th year the growth curve shows some irregularities which are due to the small number of specimens in the older age groups.

The growth calculations presented in Table 1 show that the average standard length of the muskellunge is 7.0 inches at the end of the 1st year of life. This conclusion is in accord with an observation of Webster (1930) that muskellunge planted in hatchery ponds in May attained a total length of 8 inches by the middle of October. The average calculated standard length at the end of the second year is 14.4 inches and that at the end of the 3rd year is 19.8 inches. The calculations show that the average muskellunge attains the standard length of 25.7 inches, corresponding to the legal size limit of 30

TABLE 1. CALCULATED STANDARD LENGTHS ATTAINED BY VARIOUS AGE GROUPS OF MUSKELLUNGE AT THE END OF EACH YEAR OF LIFE, AND THE NUMBER OF INDIVIDUALS COMPRISING EACH AGE GROUP

Age group	Average standard length	No.	Average calculated standard length in inches at end of each stated year of life																	
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
XIX	52.0	1	5.9	15.6	21.4	24.1	26.3	30.1	32.7	35.5	37.6	40.2	41.8	43.4	45.2	47.0	48.2	49.1	49.7	50.5	51.1
XVIII	49.5	1	11.2	22.2	24.3	25.9	29.7	32.4	34.8	36.3	37.7	38.5	39.6	42.7	44.3	45.8	46.6	47.2	48.0	48.8	....
XVII	51.3	2	7.7	14.5	20.4	27.2	33.1	35.8	38.3	45.6	42.5	44.7	46.2	47.1	48.2	46.6	49.5	50.1	50.8	....	....
XVI	42.0	1	7.0	14.0	18.2	24.0	27.2	29.7	31.8	32.6	34.9	35.8	37.0	38.0	39.1	40.1	40.9	41.4	....	....	....
XV	51.5	2	7.5	14.0	20.2	25.4	30.2	33.9	36.8	40.2	42.1	44.4	46.3	48.1	49.1	50.1	51.3	....	....	....	....
XIV	44.8	2	7.0	15.1	19.7	23.7	27.8	31.3	34.0	36.3	38.4	40.0	41.3	42.4	43.3	44.0	....	....	....	....	....
XIII	42.3	6	6.7	13.5	18.7	22.8	26.9	30.1	33.1	35.5	37.1	38.6	39.8	40.1	41.8	....	....	....	....	....	....
XII	43.5	13	6.6	13.7	20.0	25.3	29.7	33.0	35.8	37.9	39.6	41.0	42.1	43.1	....	....	....	....	....	....	....
XI	37.2	26	6.3	13.1	18.5	23.2	26.7	29.4	31.4	33.0	34.4	35.5	36.6	....	....	....	....	....	....	....	....
X	39.3	39	7.2	14.6	20.8	25.3	28.8	31.7	33.9	35.8	37.3	38.6	....	....	....	....	....	....	....	....	....
IX	37.5	39	6.5	13.7	19.3	23.6	27.7	30.9	33.2	35.0	36.5	....	....	....	....	....	....	....	....	....	....
VIII	33.8	43	6.5	13.6	19.1	23.7	27.2	29.7	31 7	33.4	....	....	....	....	....	....	....	....	....	....	....
VII	32.9	54	6.7	13.5	19.1	23.6	26.9	29.7	31.7	....	....	....	....	....	....	....	....	....	....	....	....
VI	31.9	36	7.0	14.4	20.1	24.4	27.8	30.4	....	....	....	....	....	....	....	....	....	....	....	....	....
V	28.8	20	6.8	13.3	19.1	23.6	26.8	....	....	....	....	....	....	....	....	....	....	....	....	....	....
IV	27.8	12	6.6	13.4	19.8	25.0	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
III	20.6	9	6.3	12.9	18.6	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
II	16.4	24	6.0	13.2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
I	13.3	21	7.2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
		351																			
Average length			7.0	14.4	19.8	24.4	28.2	31.3	33.8	36.4	38.0	39.7	41.2	43.1	44.4	45.6	47.3	47.0	49.5	49.7	51.1
Average increment			7.0	7.4	5.4	4.6	3.8	3.1	2.5	2.6	1.6	1.7	1.5	1.9	1.3	1.2	1.7	....	2.5	0.2	1.4

inches total length, during the 5th summer. This conclusion verifies a similar one made in the 1936 game fish report, for which only 11 specimens of this age were available (Juday and Schloemer, 1936).

The annual increment gradually decreases after the 2nd year until in the 13th year it is somewhat more than 1 inch. In comparing the growth of the first 2 years it must be remembered that while the graph shows the 2nd year's increment to be greater than that of the 1st, in reality, the converse is true.

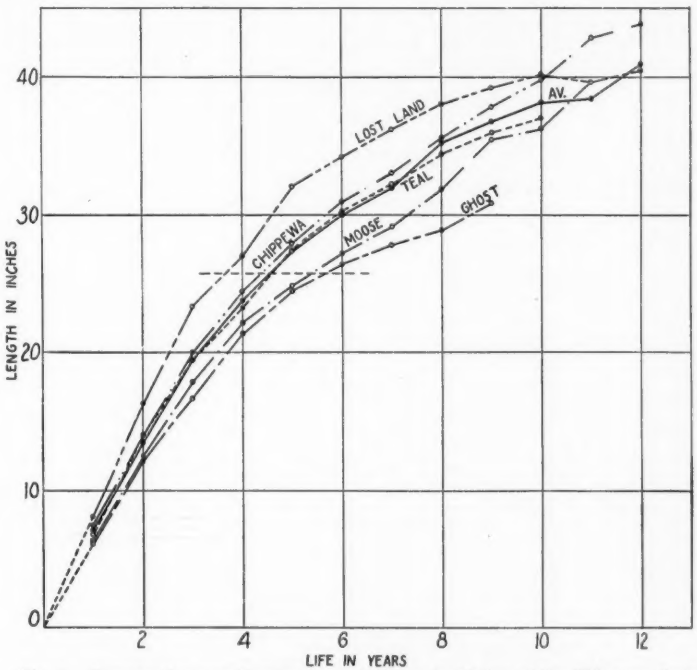

Fig. 3. Comparative growth rates of muskellunge in 5 lakes of the Chippewa drainage area and the average rate of growth of all muskellunge in the group.

This error results from the circumstance that the body–scale ratio is not exactly constant.

Growth in Different Lakes

Since approximately 46 per cent of the muskellunge included in this report come from lakes centering in 2 counties of northern Wisconsin, the muskellunge growth in closely related lakes can be studied. The Chippewa and Court Oreilles groups are situated in Sawyer county and the Manitowish group in Vilas county. They are drained by the Chippewa, Court Oreilles and Manitowish rivers, respectively.

The Chippewa Group.—The curves shown in Fig. 3 are based on the calculated lengths of 97 muskellunge; 49 of these specimens came from Chippewa Lake, commonly known as the "Flowage," 23 from Teal Lake, 16 from

Moose Lake, 6 from Ghost Lake and 3 from Lost Land Lake.

The curves show that the specimens from Lost Land Lake grew faster than those of any other lake in this group through the 10th year of life, after which they were exceeded by those of Chippewa Lake. This rapid growth, however, needs to be confirmed by a larger number of specimens, since 3 specimens are too few for a valid conclusion.

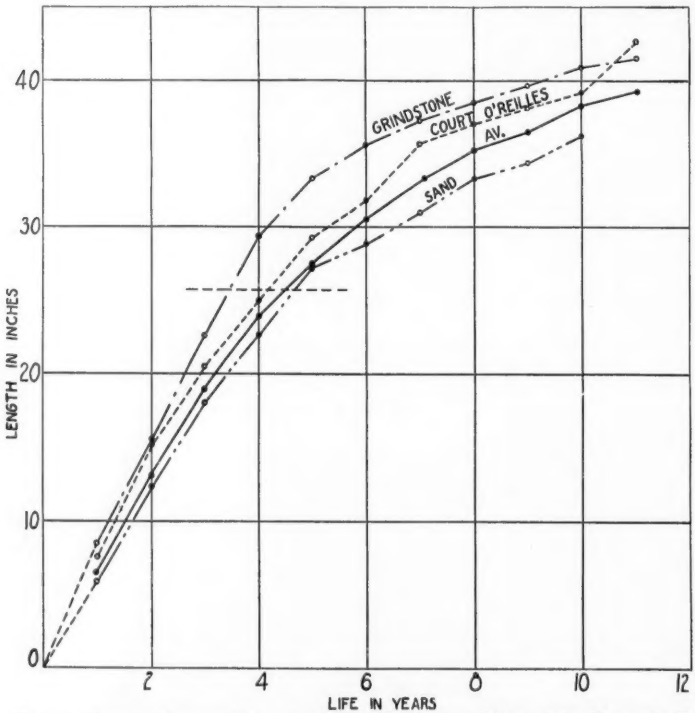

Fig. 4. Comparative growth rates of muskellunge in 3 lakes of the Court Oreilles drainage area and the average rate of growth of all muskellunge in the group.

The growth of the muskellunge from Chippewa and Teal lakes closely approximates that of the average for the group; this is explained by the fact that 74 per cent of the specimens obtained from this group of lakes came from these two bodies of water.

The growth rate of the 16 specimens from Moose Lake was below the average through the 10th year, but exceeded the average in the following year. The muskellunge from Ghost Lake had the lowest rate of growth. At the end of the 8th year of life, the Ghost Lake specimens were approximately 10 inches shorter than those of Lost Land Lake at that age—the maximum difference in size that was found for any age group. The Moose Lake specimens also were about 6 inches shorter than those of Lost Land Lake at this age, while the difference was about 1 inch greater at the end of the 7th year.

Legal length was attained by the Lost Land Lake specimens during the 4th summer, while the Chippewa and Teal Lake muskellunge, growing a little more slowly, did not reach this length until the 5th summer. The slow growing specimens from Ghost Lake needed 6 summers to reach legal length.

THE COURT OREILLES GROUP.—This group includes 3 lakes, Grindstone, Court Oreilles and Sand; 22 specimens were taken from these lakes: 15 from Sand Lake, 5 from Court Oreilles and 2 from Grindstone Lake. The results of the growth calculations are shown in Fig. 4.

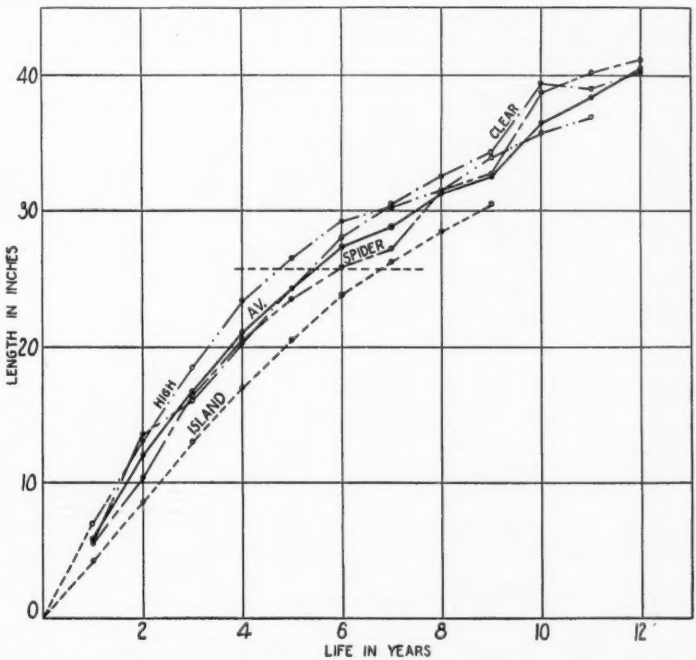

Fig. 5. Comparative growth rates of muskellunge in 4 lakes of the Manitowish drainage area and the average rate of growth of all muskellunge in the group.

The growth of the 2 muskellunge from Grindstone Lake was well above the average in all years, but conclusions on the growth of only 2 specimens are not reliable. The Court Oreilles Lake specimens were above the average in the rate of growth throughout the period of time included in the diagram, while the Sand Lake specimens were below the average in the various years. The greatest difference between maximum and minimum growths is found at the end of the 6th year, when the Grindstone Lake muskellunge were approximately 7 inches longer than those of Sand Lake.

Legal length was attained by the 2 specimens from Grindstone Lake in the 4th summer, but those from the other two lakes did not reach this size until the 5th summer.

THE MANITOWISH GROUP.—This group includes High, Clear, Spider and Island Lakes. They are represented by 41 muskellunge: 17 from High Lake, 9 from Spider Lake, 8 from Clear Lake and 7 from Island Lake. The growth curves of the muskellunge from these lakes are shown in Fig. 5.

The High Lake muskellunge showed the best growth of this group, to the end of the 7th year, when they fell below those of Clear Lake in size; later they were exceeded also by those of Spider Lake. The Spider Lake muskellunge showed an irregular growth; they exceeded the High Lake specimens during the second summer, then fell below the average until the 7th summer, after which the growth rate exceeded the average, so that finally the fish of this lake reached the maximum size, in the 11th and 12th years. The Island Lake specimens grew considerably slower than those of the other 3 lakes in this group. In the 5th and 6th years, for example, the Island Lake muskellunge were a little more than 6 inches shorter than those of High Lake at the same age; in the 9th year this difference in length had decreased to about 4 inches. These lakes are broadly connected so that fish can readily migrate from one to another, yet the Island Lake muskellunge show a consistently smaller rate of growth than those of the other lakes.

A total length of 30 inches was attained by the High Lake muskellunge during the 5th summer. While this length was reached by the Clear Lake and the Spider Lake specimens in the 6th summer, those of Island Lake required 7 summers to attain legal size.

SUMMARY

This study of the growth of muskellunge from 12 Wisconsin lakes shows that those from Lost Land Lake and Grindstone Lake had the most rapid average growth; they reached a legal length of 30 inches during the 4th summer. Those from Chippewa, Teal, Court Oreilles, Sand, and High lakes attained this length during the 5th summer; those from Moose, Ghost, Clear, and Spider lakes during the 6th summer; and those from Island Lake not until the 7th summer. The Island Lake specimens, therefore, had the slowest rate of growth.

With respect to a successful muskellunge stocking policy for these 12 lakes, the results suggest that best returns are to be expected in Lost Land and Grindstone lakes and better than average returns in Chippewa, Teal, Court Oreilles, Sand and High lakes. The other 5 lakes would yield appreciably poorer returns, with Island Lake giving the minimum.

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WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY, MADISON, WISCONSIN.

Contributions to the Life History of the Chinook and Landlocked Salmon in New Hampshire[1]

By EARL E. HOOVER

I. CHINOOK SALMON IN FRESH WATER LAKES

CHINOOK Salmon or king salmon, *Oncorhynchus tchawytscha* (Walbaum), were first introduced into New Hampshire waters under the name of California salmon in 1875, in the hope of repopulating the Connecticut and Merrimack Rivers which had become seriously depleted in ocean-run Atlantic Salmon, *Salmo salar* Linné. The disappearance of the Atlantic Salmon in the Merrimack was attributed to the construction of impassable dams in 1847; in the Connecticut, to a dam erected in 1797. Several projects to restore the salmon runs were undertaken. Chinook Salmon eggs, easier to obtain than those of the Atlantic Salmon, were imported from time to time to supplement the rivers' populations temporarily until the Atlantic Salmon were able to maintain themselves. The Atlantic Salmon were reestablished in limited numbers in the Connecticut by 1893 and in the Merrimack by 1887 (Kendall, 1935: 79), but maintained only straggling populations which were soon destroyed by pollution and inefficient fishways.

The ease with which eggs of this Pacific salmon were procured stimulated further experimentation with these fish in fresh-water lakes. The fry, fingerlings, and yearlings were distributed with little discretion into a great many lakes. Today Chinook Salmon exist in Sunapee, Squam, Waukewan, Ossipee and First Connecticut lakes, but so far as known, they have never established a self-sustaining population in fresh or salt water, either in this state or elsewhere in New England.

Little is known about the occurrence of Chinook Salmon throughout their life in fresh water or of their reaction to a landlocked environment. An investigation was therefore undertaken. During October, 1936, 77 Chinooks in spawning and post-spawning conditions were collected, weighed, measured, and stripped. The scales of each specimen were studied.

Sunapee Lake Chinook Salmon (32 studied) averaged 573 mm. (22.5 inches) in total length, 120 mm. (4.75 inches) in greatest depth, 1649.8 grams (3.65 pounds) in weight. The age at spawning was 4 or 5 years; approximately 80% of the fish were 4 years old. The salmon spawned in the lake, and apparently had completely spawned out by October 7, when collec-

[1] Published under a grant from the American Wildlife Institute for the publication of contributions fundamental to fish management.

tions were begun. Several female fish found in the stream had retained several ruptured eggs, but all females had bloody ovaries and water-logged oviducts. After spawning, the fish ascended a small tributary stream to the base of a dam where further progress was impossible. This unusual lake spawning might be attributed to the lack of suitable tributary streams, but in all of the other lakes (2 with suitable streams) a similar condition prevailed. It seems that the fish prefer to spawn in the lake and then migrate to rapidly running water.

In Ossipee Lake, it is believed, the Chinooks after spawning in the lake migrate into a tributary stream for a distance of 2 miles. Although further progress is possible in this stream, it was found that the salmon selected deep pools, extending over one-fourth mile of stream course, and remained there until death. The spent fish showed no inclination to return to the lake. It is thought that the physiological condition of the salmon after spawning induced the fish to seek water with a higher dissolved oxygen content and other desirable environmental conditions lacking in the lake.

Salmon made their initial appearance in the Sunapee Lake tributary on September 26, and some were still there on November 3. Of the 32 fish taken for study on October 7, one that was confined to a live car lived until November 3; therefore for a considerably longer time than the average length of life after spawning (11 days) or even the maximum period of survival (16 days), observed by Rutter (1903: 144) for ocean-run Chinooks. Though some fresh-water Chinooks live 15 to 30 days after spawning, others, of course, die within a few days.

Sunapee Lake was first stocked with Chinook Salmon in 1904. The first authentic record of one being caught is for 1906, according to Kendall (1913: 30), who gave the average weight of the adult fish for 1910 as 6.5 pounds, and the maximum weight as 16 pounds, 6 ounces. The largest fish taken in Sunapee Lake during the present study weighed 5.2 pounds; the 2 smallest, 4 year-old fish, 1.6 pounds, and the average, 3.65 pounds, little more than half the average weight in 1910 (the fish taken in 1910 were probably not all 4 years old).

There is little evidence to substantiate the fear of Kendall (1913: 35), that the Chinook will deplete the golden or Sunapee Trout, *Salvelinus aureolus* Bean, although the Chinook due to its voracious feeding habits may tend to reduce the numbers or size of the golden trout by a means overlooked by that author, namely, by seriously competing for food with the golden trout rather than by feeding directly on them. From all indications the population of golden trout has been increasing in Sunapee Lake during recent years, though this species as well as the Chinook Salmon has become smaller, concurrently with a serious depletion of Smelt, *Osmerus mordax* (Mitchill). The depletion of the Smelt and the increase in numbers of *Salvelinus aureolus* may not be reliable indications of natural conditions. The Smelt may have been depleted by dipping and not by the Chinook; the *aureolus* trout may have been increased in numbers by fish cultural practices and decreased in size by intensive fishing and modified legal length requirements. The fact remains, however, that when Smelt were more abundant the Chinook Salmon and golden trout both attained a larger size.

In the First Connecticut Lake, where Chinook Salmon were first stocked in 1916, 14 specimens collected after spawning in 1936 averaged 1500.6 grams (3.2 pounds) in weight and 530 mm. (20.9 inches) in total length; they were 3 and 4 years old with a surprisingly large number of 3-year fish. The Chinook taken in this lake during the last 2 years by anglers have shown a marked increase in size over those taken between 1930 and 1934; fish of 7 pounds have frequently been taken. Previous to 1930 a 10 or 12-pound fish was not unusual, but between 1930 and 1934 the average weight was only 2 to 4 pounds. In this lake also, the size of the Chinook Salmon has varied directly with the abundance of Smelt. Smelt were almost exterminated in 1931 and 1932, but under protection returned in numbers by 1934, when the Chinook increased in size.

Like the Landlocked Salmon, *Salmo sebago* Girard, which have never done well in lakes where Smelt were not abundant, the Chinook Salmon in New Hampshire also seem dependent upon Smelt.

The voracious feeding of the Chinook Salmon and their consequent reduction of the Smelt population in small bodies of water has been used in fish management. After the large race of Smelt became established in the 19-acre Ledge Pond at Madison, New Hampshire, one stocking of Chinook Salmon sufficed to completely exterminate the Smelt in 3 years. In the 62-acre Round Pond at Pittsburg, New Hampshire, the procedure and results exactly paralleled those in Ledge Pond. The Chinook Salmon have thus been used as a biological control in reclaiming small lakes where the large race of Smelt has become established. As these salmon die at 4 years of age and never establish self-sustaining populations in New Hampshire ponds, they condition the ponds for restocking with any desired game and forage fishes.

In Squam Lake, where Chinook Salmon approach the spawning beds later in the season than in Sunapee Lake, 25 mature fish taken on October 11 and 12 averaged 701 mm. (27.5 inches) in total length, 170 mm. (6.75 inches) in greatest depth and 3552.7 grams (7.86 pounds) in weight. Four-year fish predominated, but a few 5 years old were taken. Smelt, since they are abundant in Squam Lake, may account for the relatively large size attained there by the salmon.

Among the fish taken were 5 females that were ripe but had not spawned. The number of eggs averaged about 2,500 per female, approximately 250 to 300 to each pound of fish. The fertility of the stripped eggs was 92%. It is difficult to understand why eggs showing such a high fertility by artificial methods of handling do not hatch in the wild.

The salmon prefer to spawn in the lake, on beds of gravel varying in size from ½ inch to 6 inches, in water from 1 to 6 feet in depth. Redds are dug in much the same manner as described by various authorities for the Chinook in its natural waters. The redd, however, loses some of its significance when constructed along the shore of a lake where a current does not exist, for the redd does not then function as a current control or abutment for stopping the eggs. Since the current ordinarily serves as an accessory aid to the fertilization and development of the eggs, its lack may help to explain the failure of natural reproduction: spermatozoa are not so effectively carried to the ova, the fertilized eggs are not generally removed from the area of dis-

turbance and the eggs are not so well aerated during the hatching period. Many redds, furthermore, are dug in water so shallow that the eggs could not possibly escape freezing.

Since females stripped of their eggs and returned to the water continue to prepare a redd, nest building seems to be established as a function distinct from that of spawning. Belding (1935) reached a similar conclusion for the Atlantic Salmon. Furthermore, since post-spawning migrations into rapidly running water occur in Ossipee, Squam, Sunapee, Waukewan and the First Connecticut lakes, after the fish have spawned in the lake, anadromy under these conditions might also be classified as a function distinct from spawning.

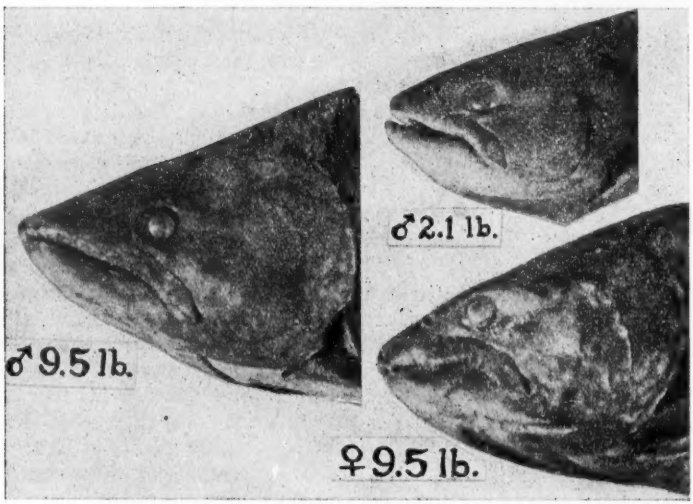

Fig. 1. Heads of 3 landlocked Chinook Salmon from New Hampshire, showing reduced sexual dimorphism, especially in the smaller male.

The average weight of 4.89 pounds for mature Chinook Salmon in all lakes studied contrasts sharply with the approximate 20 pound average for Pacific-run salmon of the same species. The sex-ratio of fish collected was 3:1, males predominating. None of the males collected exhibited extremely distorted jaws (Fig. 1), but more nearly resembled the grilse figured by Rutter (1903: text fig. on p. 131, and pl. 15, fig. D). The landlocked Chinooks of both sexes first exhibit their spawning colors in September, when the bright silver color turns to olivaceous green and the caudal, anal, pectoral and pelvic fins become spotted. The skin thickens and becomes covered with mucus. The scales become deeply embedded in the skin pockets and extremely difficult to remove.

After kindly examining scales from some of the fish collected, Seton H. Thompson of the United States Bureau of Fisheries commented: "I feel reasonably confident that the age of these fish varies from 3 to 5 years, with

the larger proportion being 4's and 5's, but I urge that other evidence be gathered before use is made of these values." Some collateral evidence exists. In Ledge, Round and Waukewan lakes, where only one stocking of Chinooks was made, the fish disappeared 4 years later. In the First Connecticut Lake, the planting of both fingerlings and yearlings in 1933 may account for the large number of 3-year fish and a predominance of 4-year spawning salmon in 1936. The experience derived from stocking indicates that the majority of the salmon attain maturity in 4 years, a very few mature in 3 years and a small proportion survive until 5 years old.

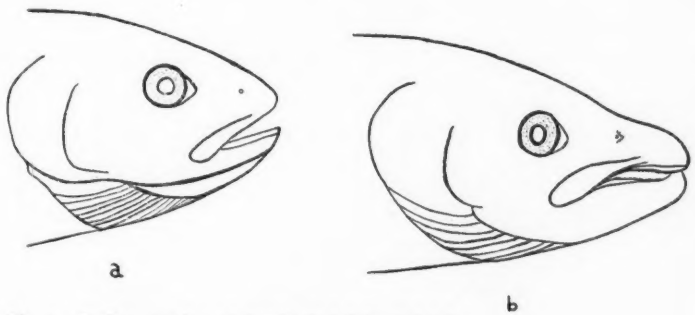

Fig. 2. Outline sketches of Landlocked Salmon heads.
a—Male grilse, 15 inches long, with 2 annuli indicating 3 growing seasons.
b—Fully adult male, 16 inches long, with 3 annuli indicating 4 growing seasons.

The scales of the landlocked Chinook Salmon vary little from those of sea-run fish. Thompson writes: "These scales are typical of Chinook Salmon. The scale characteristics closely conform to those of normal sea-run Chinooks, even to the formation of scale nuclei which heretofore have been associated with relatively slow fresh-water growth. Although scale growth in the second year of fresh-water residence is usually more vigorous than in the first, it seldom is as well marked in the sea-run Chinooks remaining in fresh water in the second year, as in these land-locked specimens. The acceleration of growth in the second year of these land-locked specimens is not comparable to that experienced by Chinooks entering the sea in their second year; however, I am wondering if there could be some change in food conditions or in the nature of the food consumed by these fish in their second year. If there is not, then we must conclude that the type of growth experienced by the anadromous Chinook is characteristic of the species and is retained in the land-locked environment."

II. The Grilse Stage of the Landlocked Salmon

Hatcherymen engaged in taking Landlocked Salmon, *Salmo sebago* Girard, in inland lakes have been frequently annoyed by the appearance of so-called "tinker" salmon which migrate into the stream and appear on the beds with actively spawning Landlocked Salmon. Male "tinker" salmon take a position downstream from an actively spawning pair of adult fish and enter into the

spawning function as soon as the larger male fish leaves his redd to drive away other males; Greeley (1933: 242–243) has reported parallel behavior in Rainbow Trout. Seven of these small salmon were obtained for examination during the past spawning season. In external appearance they compare closely with descriptions of grilse sea salmon (Menzies, 1931: 71). The scales are so easily detachable that handling a fish leaves one's hands covered with the delicate silvery scales. The tail is more forked than in the fully adult fish. The bright silvery lustre is unmarred by typical breeding colors. The head of this adolescent male fish closely resembles that of the grilse sea salmon; it is short, nicely rounded and does not assume the elongated proportions and hooked jaws characteristic of the fully adult male, but closely resembles the average female salmon head (Fig. 2). The scales of the "tinker" have 2 annuli, and therefore indicate only 3 growing seasons. The 7 examples studied were all males averaging approximately 670 grams (1.26 pounds) in weight and 355 mm. (14 inches) in length.

The identification of these grilse as Landlocked or as Atlantic Salmon was not immediately apparent, since both species (or subspecies), if distinct, have been stocked in inland lakes. On the percentile proportion distinction worked out by Kendall (1935: 137), they appear to be *Salmo sebago:* the least depth of the caudal peduncle averages more than 66% of the distance from anal to caudal fin, as usual in *Salmo sebago,* instead of not more than 66% as in *Salmo salar.* Dr. Kendall, who was kind enough to examine personally one of the grilse, also classified it as *Salmo sebago.* It is therefore believed that a grilse stage in the Landlocked Salmon has been discovered.

Since there are distinct grilse stages in *Salmo sebago,* the question arises, why there are no distinct runs of grilse like those of marine Atlantic Salmon. There are likewise no distinct runs of Atlantic Salmon grilse in the inland lakes studied. It may be significant that 8 *Salmo sebago* grilse were taken at one time in a gill-net set in a stream tributary to Sunapee Lake.

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Is *Inopsetta ischyra* (Jordan and Gilbert), from Puget Sound, Washington, a hybrid flatfish?[1]

By Leonard P. Schultz and Richard T. Smith

FOR some time the rare flounder of Puget Sound known as *Inopsetta ischyra* has been suspected of being a hybrid, although it was reported as a distinct species by Jordan and Gilbert (1880), who described it from 4 specimens, and by Villadolid (1927), who redescribed it on the basis of the 3 additional known specimens; these 7 specimens were all taken in the region of Elliot Bay and Holmes Harbor, Puget Sound.

This nominal species is well known to trawl fishermen of Saratoga Passage, by whom it is called a bastard flounder. It is said by them to be a hybrid between the starry flounder, *Platichthys stellatus,* and some other species. Capt. Michael Criscoula of the Trawler *St. Michael,* who saved for the junior author some of the specimens used in this report, is one of the fishermen who recognizes this fish at sight and regards it as a hybrid. This has also been the belief of Carl L. Hubbs and other ichthyologists for several years. The first printed statement that we have found indicating that *Inopsetta ischyra* may be a hybrid was that by Norman (1934: 376–377), who wrote: "It is possible that the single known 'species' of *Inopsetta* from Puget Sound may prove to be a hybrid between *Lepidopsetta bilineata* and *Platichthys stellatus*." Schultz and DeLacy (1936: footnote 11) were of the same opinion until the present study was made.

Only recently has it been possible to satisfy the senior author's desire of several years to analyze this problem. While engaged in a study of the fishes caught by the commercial fishermen in the Puget Sound Region, the junior author has collected 12 more specimens corresponding with the descriptions of *I. ischyra:* 4 from Saratoga Passage, off Oak Harbor, from January 26 to February 4, 1936; 7 from Saratoga Passage, off Watsak Point near Coupeville, from January 14 to February 12, 1936, and 1 from Port Discovery Bay, March 24, 1936.

These 12 new specimens agree so completely with the 2 types in the United States National Museum (No. 27266), examined by the senior author, and with the 2 descriptions of *Inopsetta ischyra,* as to leave no doubt that they represent the same species, or hybrid combination.

Several of the small-mouthed flounders of Puget Sound do not resemble *Inopsetta ischyra* closely enough to be considered possible parent species. *Glyptocephalus zachirus* and *Microstomus pacificus* have very small mouths, blunt heads, the profile rounded, smooth scales, and elongate bodies, all of which characters, among others, clearly differentiate these 2 species from *I. ischyra. Pleuronichthys coenosus* and *P. decurrens* have a rounded caudal fin, the dorsal fin beginning on the blind side opposite upper or lower lip, and smooth non-imbricated scales, and other characters that do not indicate a close relationship with *ischyra.*

Inopsetta ischyra resembles *Isopsetta isolepis* in the presence of rough scales on the median fins and in the lack of an arch in the lateral line, but

[1] This contribution was read at the 1936 meeting of the Society, on September 1.

the shape of the head and the anterior part of the body of the 2 species differ greatly. It resembles *Platichthys stellatus* in coloration, shape of body, and in other respects, except that it lacks the stellate scales of the adults of that species. It is similar to *Parophrys vetulus* and *Lepidopsetta bilineata* in shape of body and in other respects. If *Inopsetta ischyra* is a hybrid, its parents without doubt would be 2 of the 4 other species listed in this paragraph, because they are the only ones in this region that show close relationship with the supposed hybrid. A comparison of certain anatomical features of the 5 species involved in this study are given below:

1. The occipital hump at the posterior end of the extension of interorbital ridge is moderately developed in *ischyra;* absent in *L. bilineata, I. isolepis* and *P. vetulus;* very prominent and usually serrated in adults of *P. stellatus.*

2. The interorbital ridge, which extends to the rear of the head, is very distinct in *P. stellatus, P. vetulus* and *I. ischyra;* indistinct or absent posteriorly in *L. bilineata;* completely lacking in *I. isolepis.*

3. The accessory branch to the lateral line is absent in *P. stellatus;* well developed (half as long to as long as head) in *L. bilineata, I. isolepis* and *P. vetulus;* much reduced in length (about $\frac{1}{6}$ to $\frac{1}{4}$ length of the head) in *I. ischyra.*

4. The arch in the lateral line is undeveloped in *P. vetulus, I. isolepis, I. ischyra* and *P. stellatus;* very distinct in *L. bilineata.*

5. Rough ctenoid scales occur on the eyed side, and smooth or ctenoid scales on the blind side of *L. bilineata, I. isolepis* and *I. ischyra;* sometimes the scales in the larger adults of *ischyra* are very rough; the scales of *P. vetulus* are always smooth on both sides except during spawning when some of them may be rough; *P. stellatus* adults always have isolated rough stellate tubercles on the eyed side but the young usually have non-imbricated scales, that later develop into tubercles.

6. *P. stellatus, L. bilineata* and *I. isolepis* usually have rough ctenoid scales on the dorsal, anal and caudal fins (those of *isolepis,* developed most fully, extend to the tip of the rays in the adult); *I. ischyra* may or may not have a few rough scales on its median fins; *P. vetulus* lacks scales on its fins.

7. The distinct wide black color bands in the median fins of *P. stellatus* (about 5 on the dorsal, 4 on the anal, and 3 to 6 on the caudal fin) are the most characteristic feature of this species; in *I. ischyra* similar black color bands occur which are irregular and broken, and number about 5 to 8 (usually 6) on the dorsal and anal fins (those on the caudal fin are so irregular that they cannot be counted).

8. The spawning seasons as determined by the capture of ripe males and ripe females of each species are: *L. bilineata,* February and March or later; *P. vetulus,* January to March or later; *I. ischyra,* February and March or later; *P. stellatus,* January to April; and *I. isolepis,* March and April or later.

9. The type of bottom over which ripe males and females were taken in a spawning condition are: *L. bilineata,* usually a gravel to rubble bottom; *P. vetulus,* usually a bottom of soft sand mixed with mud; *I. ischyra* is taken with *stellatus* and with *vetulus,* but seldom with *L. bilineata; P. stellatus,* usually occurs over soft sand; *I. isolepis* is found on soft silty bottom.

10. Ripe males and ripe females are taken at the following depths: *L. bilineata,* 12 fathoms or less; *P. vetulus,* about 10 to 25 fathoms; *I. ischyra,* usually with *vetulus* and *stellatus; P. stellatus,* 12 fathoms or less; *I. isolepis,* down to 21 fathoms.

TABLE I. CHARACTERS OF THE SUPPOSED HYBRID FLOUNDER *"INOPSETTA ISCHYRA"* AND OF THE 4 POSSIBLE PARENT SPECIES, BASED ON SPECIMENS FROM THE PUGET SOUND REGION.

The figures for each character of each species show in the first line the minimum and the maximum count or measurement, and, in parenthesis, the number of specimens counted or measured; in the second line the mean, and the probable error of the mean. The measurements are expressed as thousandths of the standard length. The dorsal, anal and vertebral counts, except for *Inopsetta* and *Isopsetta,* are from the recent paper by Townsend (1936); 2 of the scale row counts of *Inopsetta,* are taken from Villadolid (1927). Counts and measurements of the two types of *I. ischyra* are included, when the total number of specimens used is 14 or more.

	Parophrys vetulus	*"Inopsetta ischyra"*	*Platichthys stellatus*	*Lepidopsetta bilineata*	*Isopsetta isolepis*
Dorsal rays (last single)	72–92 (202) 80.96±0.16	68–77 (14) 72.08±0.41	52–65 (203) 58.54±0.10	67–82 (233) 74.84±0.11	78–89 (108) 84.26±0.12
Anal rays (last single)	54–70 (203) 61.27±0.13	50–57 (14) 53.08±0.34	38–46 (208) 42.18±0.10	51–62 (232) 57.35±0.19	58–69 (117) 64.80±0.13
Vertebrae (hypural excluded)	42–44 (115) 43.21±0.04	38–40 (11) 39.18±0.13	34–36 (133) 35.31±0.07	38–40 (135) 39.42±0.03	40–41 (111) 40.50±0.03
Scale rows crossing lateral line	89–103 (20) 95.50±0.56	76–86 (16) 82.40±0.51	58–70 (19) 62.26±0.55	72–84 (12) 76.17±0.62	78–84 (20) 80.60±0.38
Gill-rakers above angle	4–6 (20) 4.80±0.08	4–6 (12) 5.08±0.08	3–5 (20) 3.95±0.04	3–5 (12) 3.50±0.10	4–6 (20) 4.90±0.16
Gill-rakers below angle	11–13 (20) 11.80±0.08	9–10 (12) 9.58±0.19	6–8 (20) 7.75±0.08	5–9 (12) 7.00±0.16	7–9 (20) 7.90±0.12
Pectoral rays	11–13 (20) 11.65±0.26	11–13 (14) 11.26±0.10	10–12 (20) 11.05±0.10	11 (12)	11–13 (20) 11.55±0.10
Greatest depth of body	353–399 (20) 379.2±1.8	447–505 (14) 466.7±4.7	459–529 (20) 496.0±2.6	444–490 (12) 466.9±2.3	421–478 (20) 443.6±2.3
Head length	267–301 (20) 282.5±1.3	285–317 (14) 294.7±1.8	284–321 (20) 304.1±1.5	273–294 (12) 276.5±1.2	245–283 (20) 262.6±1.4
Length accessory branch of lateral line	146–252 (20) 186.6±4.4	15–102 (14) 61.5±4.4	(lacking arch)	76–153 (12) 104.4±4.7	167–307 (20) 229.0±4.4
Height of arch of lateral line	3–17 (20) 11.0±0.6	9–23 (14) 14.4±0.8	17–40 (20) 22.3±0.8	42–63 (12) 48.6±1.0	14–30 (20) 20.8±0.7
Snout length	56–69 (20) 60.6±0.4	52–71 (14) 58.9±1.4	56–73 (20) 65.6±0.9	46–69 (12) 60.8±1.1	42–63 (20) 50.8±0.8
Bony interorbital width	5–12 (20) 8.6±0.2	7–12 (14) 9.9±0.4	8–15 (20) 11.6±0.3	4–8 (12) 5.7±0.2	5–10 (20) 7.0±0.2
Snout to pelvic fin insertion	271–297 (20) 281.8±1.0	283–328 (14) 294.4±2.0	285–361 (20) 307.4±2.5	266–333 (12) 292.9±4.1	234–316 (20) 265.4±2.2
Least depth of caudal peduncle	77–97 (20) 86.8±0.8	89–108 (14) 97.1±1.2	87–109 (20) 99.2±0.8	100–116 (12) 106.7±1.0	94–115 (20) 107.0±0.6
Length of caudal peduncle	97–124 (20) 107.7±1.1	94–126 (14) 108.8±1.5	100–156 (20) 129.5±1.9	78–100 (12) 94.8±1.3	63–86 (20) 73.6±0.8

A study of the characteristics listed above indicates that *I. ischyra* is intermediate between *P. vetulus* and *P. stellatus,* or is similar to these 2 species in all features discussed. *I. ischyra* is intermediate between *P. stellatus* and the other 3 species *(L. bilineata, I. isolepis* and *P. vetulus)* in the characters numbered 1 and 3, but since these 2 characters are alike in *L. bilineata, I. isolepis* and *P. vetulus,* they indicate little as to which of the 3 species might be the parents. All 5 species are alike in regard to the spawning season (8). *I. ischyra* shows no clear intermediacy between *P. stellatus* and *L. bilineata* in characters 2, 4 and 9, nor between *P. stellatus* and *I. isolepis* in characters 2 and 9. The differences between *I. ischyra* and *I. isolepis* mentioned above further suggest that *I. isolepis* is not one of the parent species.

Since *I. ischyra* is intermediate between *P. stellatus* and *P. vetulus* in 5 characters and similar or alike in 4 others, mentioned above, we conclude

that *Inopsetta ischyra* is probably a hybrid between *Platichthys stellatus* and *Parophrys vetulus.*

A study of several counts and measurements corroborates this conclusion based on a study of the characters discussed above. An examination of Table I reveals that *Platichthys stellatus* is the only one of the 4 possible parent species that has fewer vertebrae, fewer dorsal rays, fewer anal rays and fewer scales than *I. ischyra;* none of the other 3 species has these elements quite so few. It therefore appears most probable that *P. stellatus* is one of the parent species, because fish hybrids have been found by various authors to be intermediate between the parent species. *I. ischyra* is intermediate between *P. stellatus* and *Parophrys vetulus* in regard to: (1) number of rays in dorsal and anal fins; (2) number of vertebrae; (3) number of scale rows crossing the lateral line; (4) number of gill-rakers on the lower portion of the gill-arch. *I. ischyra* is intermediate between *P. stellatus* and *I. isolepis* only in the number of dorsal and anal fin rays. *I. ischyra* is not definitely intermediate between *P. stellatus* and *L. bilineata* in regard to number of fin rays, scales or vertebrae. The differences in number of pectoral rays seem to be of little significance. The number of principle caudal fin rays is usually constant at about 18 in the 5 species. These data, therefore, virtually eliminate *I. isolepis* and *L. bilineata* from consideration as parent species of *I. ischyra.* Instead, the data indicate that *P. stellatus* is one parent and *P. vetulus the* other.

Numerous measurements made on the 5 species of flatfish treated in this study, expressed in thousandths of the standard length and also presented in Table I, show that *I. ischyra* is intermediate between *P. stellatus* and *P. vetulus* in (1) depth of body, (2) height of arch of lateral line, (3) width of the bony interorbital space, (4) distance from snout to pelvic insertion, (5) least depth of caudal peduncle, (6) length of caudal peduncle, (7) length of head and (8) length of accessory dorsal branch of lateral line. *I. ischyra* is intermediate between *P. stellatus* and *L. bilineata* in (1) width of bony interorbital, (2) length of caudal peduncle, (3) length of accessory dorsal branch of lateral line, and possibly in (4) the distance from the snout to the insertion of the pelvic fin, (5) width of body and (6) length of caudal peduncle. *I. ischyra* is intermediate between *P. stellatus* and *I. isolepis* in (1) depth of body, (2) length of accessory dorsal branch of lateral line, (3) length of snout, (4) width of bony interobital space, (5) length of caudal peduncle, (6) length of head and (7) distance from snout to pelvic fin insertion. None of the 5 species differs very much from each other in the length of the snout and the length of the head. *I. ischyra* corresponds to the probable combination of *P. stellatus* $\times$ *P. vetulus* combination in 1 more character than to the improbable combination of *P. stellatus* $\times$ *I. isolepis,* and in 2 more characters than in the likewise improbable combination of *P. stellatus* and *L. bilneata.* The measurements, therefore, substantiate the findings in the 2 previous parts of this report, that *I. ischyra* is most definitely intermediate between *P. stellatus* and *P. vetulus.*

Among 12 specimens in our possession of *I. ischyra* 10 have their color on the right side and 2 on the left. About one-half of *P. stellatus* caught in this region are sinistral, while but 1 of *P. vetulus* was left-handled among 4732 observed. Among 1509 specimens of *L. bilineata* and 1812 of *I. isolepis* ex-

amined, all were dextral. The fact that one-sixth of the *I. ischyra* specimens taken by us are sinistral indicates hybridization with a species such as *P. stellatus,* which normally is in part left-handed.

The rarity of the form called *Inopsetta ischyra* lends support to the theory that it is a hybrid between *Platichthys stellatus* and *Parophrys vetulus.* Only single specimens appear now and then in the commercial catch of millions of flatfish in this region. All of the other species of flatfish in this region occur in abundance in some area in certain habitats.

We conclude from our data that *Inopsetta ischyra* is a hybrid between 2 common flatfish in the Puget Sound region, namely *Platichthys stellatus* and *Parophrys vetulus.*

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Two New Species of Naked Soles from the Gulf of Mexico, with Notes on a Third Species

By Gordon Gunter

THIS paper deals with naked soles which are placed in the genus *Nodogymnus,* described by Chabanaud (1928). Two new species are described, from the Gulf of Mexico.

1. *Nodogymnus* ***williamsoni,*** new species
Figs. 1, 4 and 5

Holotype.—U. S. N. M. 102032, a specimen 145 mm. in total length, taken in a shrimp trawl a few miles off West Pass of Apalachicola Bay, western Florida, about December 10, 1935. It was given to me through the kindness of Mr. George S. Hiles of Apalachicola.

The species is named in honor of the late Prof. George Williamson, savant and teacher of natural history of the Louisiana State Normal College.

DIAGNOSIS.—Dorsal, about 70; anal, 47; caudal, 17; right pelvic, 5; left pelvic, 5. Total length, 14.5 cm.; standard length, 11.4 cm. Depth (without fins) in standard length, 1.7; head in standard length, 5.3; eye in head, 5.7.

Since the skin is very thick over almost all the surface of the fins, since the sensorial fringes in the cephalic region are much like the anterior rays of the dorsal and since the type went into rigor mortis with the fins twisted, an accurate count of the rays is impossible without dissection. Chabanaud (1928) and Kendall (1911) have had similar difficulties with other species.

EYED SIDE.—The eyes, very small and close set, are connected and partly covered by a common membrane. The eyes are on a line vertically, as neither is placed farther forward than the other.

There are no teeth.

The short but large anterior nasal tube is inserted on a level with the upper margin of the ventral eye, slightly less than halfway between the eyes and the end of the snout. The posterior tube opens just above the angle of the mouth, under the fold of the prebuccal prolongation. The slit of the rather small mouth is not straight, but extends longitudinally and is not turned down posteriorly. There are several fleshy cilia on the prebuccal prolongation and the lower lip.

The right pectoral fin is a mere papilla situated above and slightly back of the end of the gill-cleft, just under the level of the mouth slit. No rays were present above the skin, but the tiny rudiments of 2 were seen when the skin wore through as it did on much of the fin edges. The skin of this fish is very loose and wrinkled, giving the impression of being much too large for the animal. It is smoother than that of the following species.

The urinary papilla is above the last pelvic ray and lower than the anus on the opposite side.

The lateral line of the body is practically straight. Back of the head region are 9 accessory vertical lines, of which the last one is at the juncture of the body and caudal fin. The complex pattern on the head can best be understood by an examination of Fig. 1. These lines consist of a cordon on which stand short minute tubules, which are not equally spaced, and become less frequent near the fins. The exact delineation is hard to follow on the head, because of the unequal spacing of the tubules and because at some places where the lines branch the tubes lose their linear spacing and form small sensory areas.

On the body proper the accessory lines run along the middle of the heavier dark color lines described below. Near the fin edges, as the color lines turn posteriorly, the sensory lines run straight to the edges of the fin, leaving the original color line and crossing the ends of other bands.

There are 22 dull black, heavy, vertical lines on head, body and fins; the lines are extended onto the dorsal and anal fins, on which they are curved posteriorly. Of the 6 lines on the head region, the first 2 are less distinct than the others. There are 4 on the caudal fin. These lines, widest along the

middle of the body, are separated from one another by a space as wide as to slightly wider than the lines. Between the heavy bands are 16 lighter, in part indistinct, narrower lines, also extended onto the vertical fins but becoming less distinct at the edges. Both types of lines are on a background of dull, smudgy gray which looks as if the white would almost break through in spots. The color was described from the type specimen when fresh. Fig. 4 shows the pattern.

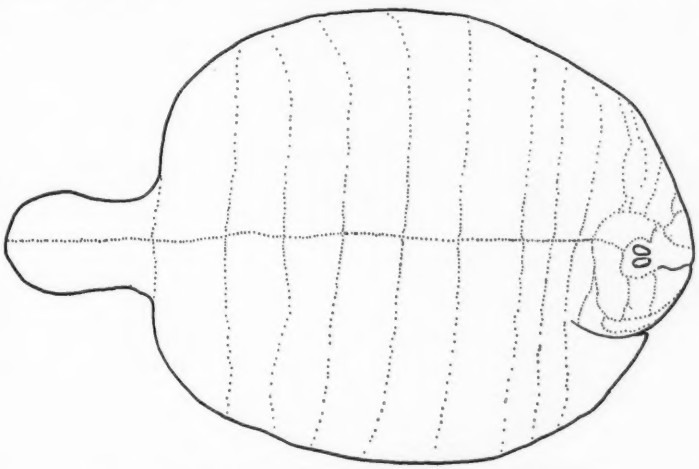

Fig. 1. Lateral line pattern on type of *Nodogymnus williamsoni*.

BLIND SIDE.—The mouth opening is slightly more than half as long as on the eyed face and curves downward posteriorly. Nasal tubes were not seen. There is no left pectoral. The anus is above the last 2 pelvic rays and on an oblong, slightly raised area bordered by a ring of dusky cilia. The whole anterior cephalic region is covered with dusky sensorial hairs in a reticulated pattern, which extends posteriorly along the body edge to the fins, becoming thinner and disappearing at slightly less than midway of the body.

The pelvic fins are bound together at the base but the ends are free and the left fin is slightly the more anteriorly placed.

The lateral line is single and straight. It extends to the tip of the caudal fin, and ends anteriorly among the sensory hairs about halfway on the head.

The blind side of the specimen when fresh was enamel white, becoming dusky and ranging into black at the edges of the median fins. This dark area is wider at the posterior region of the body and covers slightly more than half of the caudal fin. An irregular series of small blotches starting on the caudal fin runs forward on each side of the lateral line to about the middle of the body, there becoming almost indistinguishable although a faint spot can be seen almost as far forward as the head. The edges of the fins are not white as in some related species. Fig. 5 is from a photograph of the blind side.

2. *Nodogymnus* ***texae,*** new species
Figs. 2 and 3

HOLOTYPE.—U. S. N. M. 94559, a specimen 101 mm. in total length, taken in a shrimp trawl off Padre Island, Port Aransas, Texas, in 1934, and presented to the United States National Museum by Prof. C. T. Reed of the Texas College of Arts and Industries, Kingsville, Texas. It was loaned to me for description through the courtesy of Dr. George S. Myers of the National Museum.

The species is named after the State of Texas.

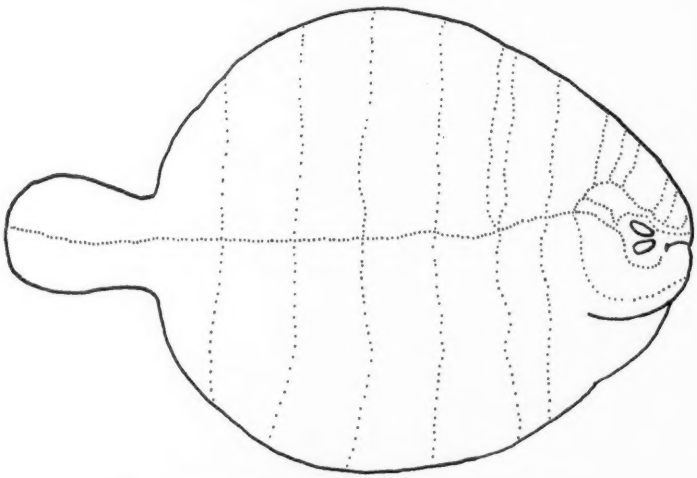

Fig. 2. Lateral line pattern on type of *Nodogymnus texae.*

DIAGNOSIS.—Dorsal, about 61; anal, 45; caudal, 15; right pelvic, 5; left pelvic, 5. The last pelvic rays are rudimentary. Total length, 10.1 cm.; standard length, 7.9 cm. Depth (without fins) in standard length, 1.9; head in standard length, 5.0; eye in head, 4.1.

EYED SIDE.—The large eyes, closely spaced, are joined together and partly covered by a common membrance. The eyes are on a line vertically.

The mouth slit reaches almost to the ventral eye. It is small and curves downward posteriorly. The edge of the prebuccal prolongation and the lower lip are fringed with cilia.

The anterior nasal tube is on a level with the ventral eye, just over the posterior end of the mouth and one-fourth the distance from the eye to the tip of the muzzle. The posterior tube is situated under and only slightly behind the anterior tube, under the fold of the prebuccal prolongation.

The right pectoral fin is slightly below the mouth level and a short distance posterior to the end of the gill-cleft. It consists of a single ray.

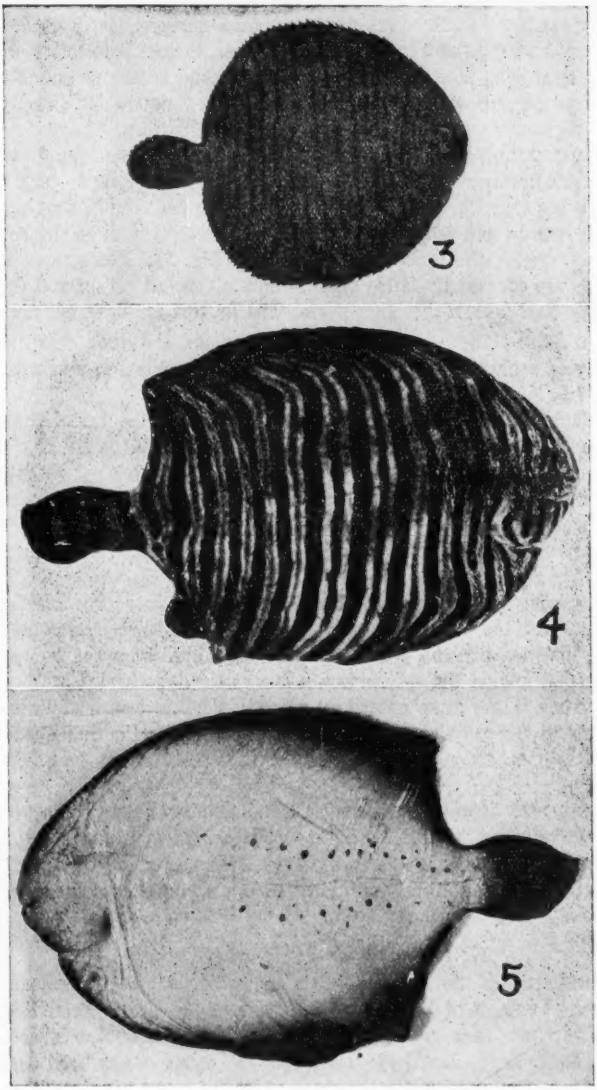

Fig. 3. Holotype of *Nodogymnus texae*, eyed side.

Fig. 4. Holotype of *Nodogymnus williamsoni*, eyed side.

Fig. 5. Holotype of *Nodogymnus williamsoni*, blind side.

The urinary papilla is above the insertion of the first anal ray and is below and posterior to the anus on the opposite surface.

Behind the head there are 6 accessory vertical lines connecting with the median lateral line. The superior part of the second accessory line is double. The pattern of sensory lines on the head, approximately indicated in Fig. 2, is complex.

The background in alcohol is a dark fawn brown, crossed by 32 vertical, narrow, dark brown stripes, extending from edge of dorsal fin to edge of anal fin. They are irregular and somewhat difficult to describe in that some are dark near one fin and fade away near the main lateral line; in the head and caudal fin regions, the lines are not straight (Fig. 3). The spaces between the stripes are coursed by faded obscure lines. The tail region and fin edges are slightly darker than the other parts. The fin tips are light but not white.

BLIND SIDE.—The mouth slit is very short and is turned sharply down. The anterior cephalic border is covered with sensory hairs, much as in *N. williamsoni*. Nasal tubes were not seen.

The lateral line is single and straight, running to the tip of the caudal fin and ending anteriorly in several indistinct branches in the anterior ciliated area.

The color is a light dirty brown, becoming darker on the vertical fins, through which the stripes of the eyed side may be seen faintly. There are a few very small darker splotches directly on the lateral line and a half centimeter to the right of it.

This species differs markedly in color pattern from *N. nicholsi* Norman (1931), in that the stripes are much narrower and more numerous, fading alternate lines are present, and there is no dark border on the fin edges. It differs further in that the eyes are on a line vertically, whereas in *N. nicholsi* the lower one is the more anteriorly placed. Vertical sensorial lines and a right pectoral fin are also present in contradistinction to that species. As indicated by Chabanaud (1928), the last characteristic may be of little importance.

The fish also differs from Kendall's and Günther's specimens of *Nodogymnus fasciatus* in having the eyes perfectly aligned vertically, the nasal tubules relatively closer to the ventral eye, eyes larger in proportion to the head, vertical sensorial lines, and more numerous and finer color stripes giving a plainly different color pattern.

3. *Nodogymnus fasciatus* (Günther)

A specimen of this species (Catalogue No. 91552) was loaned me through the kindness of Dr. George S. Myers of the United States National Museum. It was taken by the United States Fish Commission Steamer *Fish Hawk* at Long Keys, Florida, in 1903. Unfortunately it has been desiccated and is difficult to examine, but it was so well described by Kendall (1911), under the name *Gymnachirus fasciatus*, that his description will suffice for comparison with the other species here treated.

It is toothless and belongs in the genus *Nodogymnus* of Chabanaud (1928). Nevertheless, I could not discover nostril openings on the blind face, with the use of binoculars, but the dried condition of the fish, the abundance

of cilia and the possibly small size of the nostrils on this face make me uncertain of this point. No vertical lateral lines were seen. Presumably this specimen is referable to *Nodogymnus fasciatus* (Günther).[1]

General Considerations

The taxonomic significance of the accessory, vertical lateral lines, as described above, is puzzling. Apparently they are also present in some species or specimens of *Achirus, Trinectes, Achiropsis* and *Hypoclinemus* (personal communication of Dr. Myers) but for some reason have been largely disregarded or overlooked. Dr. Chabanaud has advanced the idea (personal communication) that possibly these lines could be revealed in fish where they are apparently absent, by making histological sections of the skin.

It is a noteworthy fact that since Kaup (1858) described the first naked sole, almost every specimen caught has been described as a new species. Naked soles seem to be very rare although they possibly are inhabitants of deep water and are therefore seldom caught.

Seven species have been described, including the present 2. All but 1 have been reported from North America, and 5 from there alone. These fish are described in the papers of Kendall (1911), Nichols (1916), Nichols and Heilner (1928), Chabanaud (1928) and Norman (1931).

The writer is indebted to Dr. Paul Chabanaud of the Museum d'Histoire Naturelle, Mr. J. R. Norman of the British Museum (Natural History), Mr. J. T. Nichols of the American Museum of Natural History and Dr. G. S. Myers of the United States National Museum, who have corresponded freely concerning the naked soles. I am also indebted to Mr. R. O. Smith of the United States Bureau of Fisheries for the photographs.

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Texas Oyster Development Corporation, Palacios, Texas.

[1] The fish reported by Kendall (1911) as *Gymnachirus nudus* Kaup, from Tisbury Great Pond, on Marthas Vineyard, has been examined by Dr. G. S. Myers, who reports that it is toothless and appears to be a *Nodogymnus*, probably identical with Nichols' *Nodogymnus melas*, described from a much smaller North Carolina example.

A Race of Wild Carp Lacking Pelvic Fins[1]

By David H. Thompson and Leverett A. Adams

In September, 1934, we learned from Mr. Henry Kern of Waukegan, Illinois, an Investigator for the Illinois Department of Conservation, that a large proportion of the carp (*Cyprinus carpio* Linnaeus) of Crooked and Hastings lakes, in Lake County, Illinois, lack pelvic fins. These unusual fish (Figs. 15 and 16) were first noticed in 1929, when commercial fishermen began to seine these lakes. The abnormality might have gone unnoticed had not one of the fishermen made the remark, at that time, that some of the carp in this lake lacked one of his favorite hand holds. Examination of the carp from commercial seine hauls made on September 22 and November 7, 1934, showed the following numbers of normal and abnormal individuals:

	Normal Fish	Abnormal Fish	
	Two fins	No fins	One fin
September 22, 1934	79	22	13
November 7, 1934	31	8	4
	110	30	17

About 30 percent are abnormal, and of the abnormals about one-third have one pelvic fin. A degree of abnormality was also shown by some of the fish with both pelvics: counts of the pelvic rays in the collection of November 7 from Crooked Lake disclosed 2 carp with both pelvic fins that had fewer than the normal number of pelvic rays (9 or occasionally 8 is the number shown by carp in other Illinois waters).

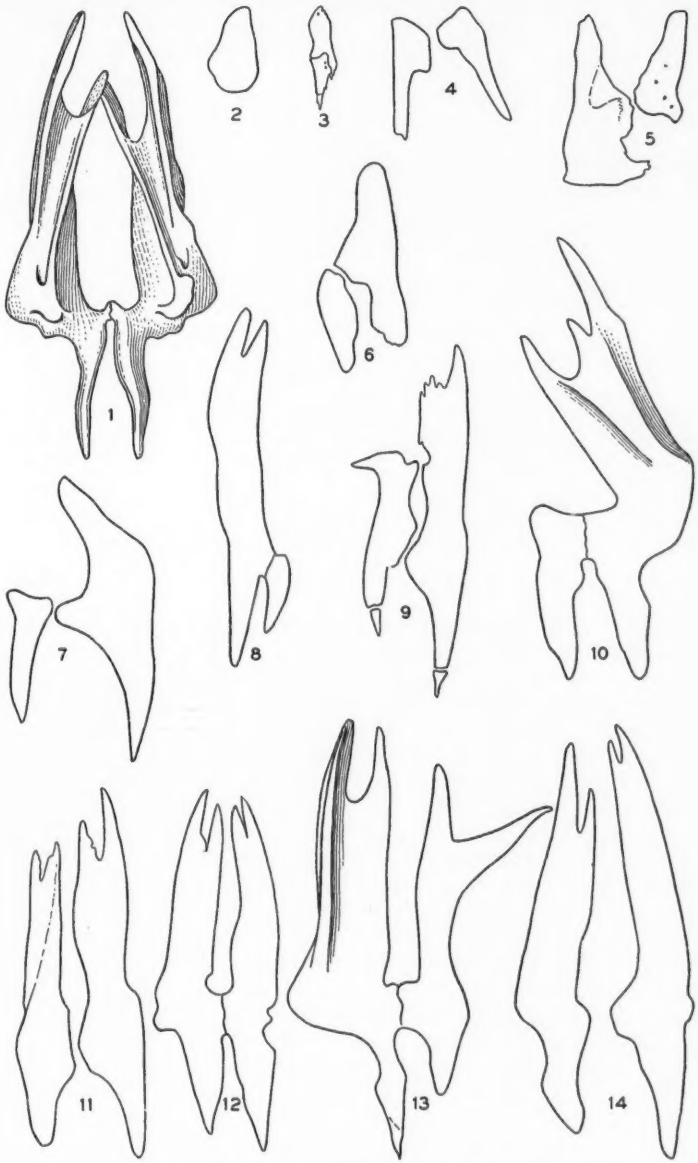
In every individual examined that lacked both pelvic fins the pelvic region is completely covered with scales. In most abnormals the scale rows of the belly continue across this region without interruption and the scales are uniformly graded and fairly regular in shape. In a few others the scale pattern is more or less broken up; the rows are indistinct; the scales are of irregular sizes, and a few of them are notched and malformed.

Sixteen abnormals and 2 normals were brought into the laboratory for a more detailed examination. All fins other than the pelvics consistently showed the ordinary ray counts of carp, and appeared to be of normal size and shape. These carp were of usual sizes, and ages, ranging from 15 to 22 inches in standard length, and from 2 to 9 years in age, according to scale readings. In the collection of November 7, the average length of the 12 abnormals was within 0.2 inch of the average length of the 31 normals.

The internal condition of the pelvic region was examined in detail (by Adams) in 14 abnormals and 2 normals. The pelvic girdles were exposed and sketched *in situ* from the inner (dorsal) aspect. Normal pelvic bones are compared with those of 13 abnormal girdles in Figs. 1–14.

The lengths of the right and left halves of a normal carp pelvis and of 14 abnormal ones are given in Table 1. Since the normal pelvic girdle is about 14.4 percent of the standard length, the percent of reduction from the

[1] Paper presented at the Ann Arbor meeting of the Society, on August 31, 1936. Contribution No. 500 from the Zoological Laboratory of the University of Illinois.



Figs. 1 to 14. Pelvic girdles of 14 Illinois carp, normal (Fig. 1) and abnormal.
These girdles are drawn to scale; the measurements are given in Table 1.

normal girdle length has been calculated. In order to show the relation of the internal development of pelvic apparatus to the external fin, the number of rays attached to each pelvis has been included.

TABLE 1. ABNORMALITIES IN THE PELVIS AND PELVIC FINS OF CARP

Carp No.	Fig. No.	Standard Length, mm.	Left Side			Right Side		
			Length Pelvis, mm.	Percent Reduction	No. of Rays	Length Pelvis, mm.	Percent Reduction	No. of Rays
1	1	370	53	0	9	53	0	9
2	2	400	missing	100	0	10	83	0
3	3	400	4	93	0	7	88	0
4	4	530	14½	81	0	14	82	0
5	5	400	20	65	0	13	77	0
6	6	500	13	82	0	22	69	0
7	7	530	16	79	0	32	58	0
8	8	510	42	43	0	10	86	0
9	9	400	21	64	0	41	29	0
10	10	550	15	81	0	62	21	7
11	11	400	34	41	0	46	20	0
12	12	530	42	45	5	46	40	1
13	13	530	53	31	9	38	51	0
14	14	560	50	38	0	52	35	0
15	..	480	51	27	6	55	21	8

All 14 carp showing reduction or absence of the external pelvic fins also show striking reduction and abnormality in the pelvic bones. Nevertheless, some remnant of the girdle is found in every individual. There seems to be very little correlation between the two halves of the pelvis. One half may be almost normal in size and shape, and bear a normal fin, while the other may be strikingly degenerate. In one fish, the pelvic bone of one side is entirely missing and its mate represented by a small nodule of bone. In some it is reduced to a thin scale of degenerating bone peppered with small holes. In most specimens, the two halves are bound together, sometimes closely and sometimes loosely by a ligament, or fibrous band; in a few they are quite separate. Most of the pelvic vestiges are more or less shifted in position and the line of articulation of the two halves is frequently askew. The posterior part of the girdle seems more persistent than the anterior part. In a few these posterior parts are tipped with cartilage.

The pelvic bones bearing fins in abnormal fish show an average reduction of 31 percent. The mates to these, lacking fins, show 66 percent reduction. Pelvics from fish lacking both fins also average 66 percent loss in length. Those pelvic bones which bear more or less complete fins are not only more than 50 percent of normal length, but also, still more consistently, show a well-defined lateral surface or shoulder which bears the acetabulum for the articulation of the radials. Pelvic musculature is always present. The muscles associated with the more nearly normal pelvic bones are rather well-developed, whether they bear fins or not. In the more vestigial types of pelvis, the musculature is reduced to a few strands on the dorsal side.

The fact that the pelvic fins in the abnormal carp are associated with the larger pelvic bones suggests that the internal pelvic rudiment stimulates the formation of an external fin, and that reduction of the rudiment beyond a certain point results in no fin. We may then suppose that the absence of a fin results from a preceding effect on the girdle.

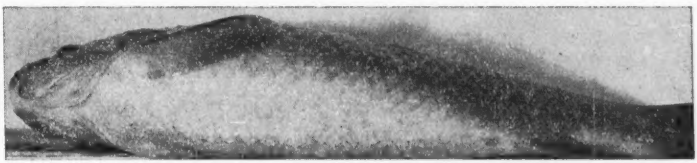


Fig. 15. Ventral view of a carp lacking both pelvic fins.

It is very unlikely that the extreme degeneration of the girdle found here could result from the mechanical injury and removal of the fins. It is also hard to imagine a disease specific for the pelvic apparatus of carp in these two lakes. Although abnormalities of other kinds, such as bifurcation of the primitive streak, cyclopean monsters, altered number of scales or vertebrae, the "Mopskopf" anomaly and various diet deficiency effects, have been known to result from unfavorable environmental conditions during early development, so far as we know such conditions have never resulted in the loss of the pelvic girdle or fins. Conditions for development of carp eggs and fry appear to be no different in these 2 lakes than in a number of other lakes in this region which have been studied in considerable detail, and which contain normal carp. The fact that carp without pelvic fins were seen in these lakes as early as 1929, and the fact that abnormals taken in 1934 show the same size and age distributions as normals, seem to show that the abnormality does not result from any unusual environmental condition or circumstance. Therefore, it is most probably genetic.

The abnormal carp form an isolated population. Since Crooked and Hastings lakes, in which they occur, drain through Mill Creek into the Des Plaines River, these carp are separated from those inhabiting the lakes of the Fox River drainage. The carp of Crooked and Hastings lakes have been effectively isolated from the Illinois and Kankakee River stocks by the extreme pollution of the lower course of the Des Plaines in the vicinity of Chicago. The partial cleaning up in recent years of the Des Plaines may explain the taking, this year, of our first carp without pelvic fins from the Illinois River, at Henry.

This pelvic fin abnormality in the carp of Crooked and Hastings lakes is probably of recent origin. Carp had not been introduced into the lakes of Lake County in 1886, although they were certainly present in almost all of them by 1900. As there was a great interest in this newly-imported fish and its different domestic varieties during these years, it seems likely that even a few lacking fins would have been noticed. Although it seems improbable that these lakes were stocked with carp lacking pelvics, such fish must have appeared within the next decade or two in order to have spread

through 30 percent of the population by 1934 (the population is roughly estimated at 50,000 breeding fish).

Last spring one of the authors (Thompson) tried, unsuccessfully, to obtain spawning carp, both normals and abnormals, from which eggs could be stripped and fertilized. By classifying young hatched from such crosses, one should be able to make a fairly complete genetic analysis. If the char-

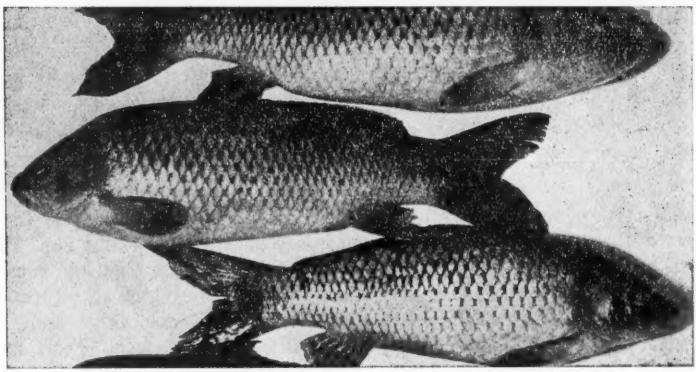


Fig. 16. Lateral view of 3 carp lacking both pelvic fins.

acter is a simple dominant which always manifests itself, we can say that 30 percent of the population carries the mutant gene. If it is a recessive character; or if it is the result of multiple factors; or, again, if the gene or genes fail to manifest themselves regularly (which is suggested by the number of single fins and imperfect pairs), it is certain that the hereditary factors for the lack of fins are scattered through a larger fraction than 30 percent of the population.

The details of the method of inheritance do not seem so important as do certain other considerations. The pelvic girdle and its paired appendages are supposed to be fundamental anatomical structures of great phylogenetic age. But here are carp without pelvic fins, competing unaided with fully-equipped wild carp and apparently crowding them out.

An example of mutations which are eliminated in nature is furnished by a study of the abnormalities in the scales of carp in Illinois. Although about two-thirds of the original stock of carp planted in Illinois waters in the 1880's were of the "mirror" and "leather" domesticated varieties, in the wild state the proportion of these varieties has gradually decreased until they now make up only 1 or 2 percent of the population. The pelvic abnormality, on the contrary, appears to be on the increase. According to our present views, it is the occasional mutation of this type, which survives and spreads through the population, either by selective advantage or by the indifferent forces of species drift, that constitutes evolution.

Reduction of the pelvic girdle has taken place in many kinds of vertebrates—the whale, the snake, the siren and a number of fishes. In all of

these, the external appendages have disappeared, but in many of them there remain internal vestiges of the girdle very much as in the abnormal carp. These changes are usually supposed to have occupied long periods of geologic time, but in these carp we may be witnessing a comparable amount of evolution within a short period of years. This evolution is going fast enough so that one man could hope to measure an appreciable amount of it in his lifetime. And it appears that this is evolution, no matter whether we regard it from the standpoint of the spread of new genes through a population, or from the older viewpoint of the comparative anatomist.

ILLINOIS STATE NATURAL HISTORY SURVEY, and UNIVERSITY OF ILLINOIS, URBANA, ILLINOIS.

The Frogs and Toads of Eastern North Carolina

By B. B. BRANDT

EASTERN North Carolina possesses an abundant salientian fauna. Surveys of the frogs and toads of the region are, however, few. Brimley (1896) reported eleven species from Raleigh; seventeen from various counties of eastern North Carolina (1907); seven from Craven County and one from Cape Hatteras (1909). Meyers (1924) listed eight species from Wilmington. Brimley and Mabee (1925) reported five eastern North Carolina species. In his revised key, Brimley (1926) brought the records for North Carolina up to date and gave the range of the twenty species known to occur in the state. In a later paper, Brimley (1927) presented additional range records and, Brady (1927) listed eight species from the "Dismal Swamp."

The writer's observations were made chiefly in Beaufort County with incidental excursions to other counties. They extended from May, 1931, to December, 1933, with occasional observations later. The field work had to be done chiefly at night and included over one hundred separate excursions.

Scientific names are based chiefly on the check list of Stejneger and Barbour (1933). Ranges in North Carolina are based chiefly on Brimley's papers (1926, 1927). Satisfactory keys for identifying the species of the region, except for *Pseudacris brimleyi*, are provided by Wright and Wright, 1933.

The writer is indebted to Dr. I. E. Gray of Duke University for unfailing stimulation and criticism and to Mr. George Ross and Miss Mary Shelbourne of the Washington Field Museum, who were of constant assistance on the numerous field trips. Aid and criticism were rendered by Mr. C. S. Brimley, Raleigh, North Carolina; Dr. A. H. Wright, Cornell University; Mrs. Helen T. Gaige, University of Michigan; Dr. C. F. Walker, Ohio State Museum; Dr. A. S. Pearse, Duke University; and Mr. Percy Viosca, New Orleans, Louisiana.

List of Species

Scaphiopus holbrookii holbrookii (Harlan)

Brimley (1926) gives Wake, Carteret and Henderson counties as the range in North Carolina of the spadefoot. The writer has taken the species in the counties of Beaufort, Pitt, Greene, Wilson and Nash. Dr. Gray has shown me specimens which he took at a breeding congress in Columbus County. The species is abundant in Beaufort County but is seldom seen on account of its fossorial habit, which it seldom abandons except at time of heavy rains and during the breeding season. The writer has never observed the breeding activity at the ponds to last more than two consecutive nights. The spadefoot occurs more commonly in dry sandy areas; in fact, one may find hibernating individuals in midwinter by digging at random near the summits of sandy knolls.

Although the great majority of the spadefoots appear to hibernate, active individuals have been taken in every month of the year. One individual floating in an extensive pond was taken on February 1. A breeding congress was observed on the night of March 20, 1933, when hundreds of the animals were congregated in small, shallow ponds, ditches and puddles. The noise was deafening. The larger, deeper ponds appeared to be avoided and the greatest numbers were observed at water holes in the vicinity of sandy areas. Numerous pairs in inguinal embrace and one case of belly-to-belly amplexus were observed. Warm heavy rains had fallen for four days prior to the congress. The minimum air temperatures of the previous two days exceeded 60° F: the maximum air temperatures of these two days were 77° and 82° F. This was the first period of protracted warm rains of the spring. Whether a second congress can be initiated by a recurrence of such conditions remains undetermined; however, a similar combination of conditions of heavy rainfall and high temperature failed to bring about a congress early in May of the same year. Specimens taken at various seasons ranged in length from 29.5 mm. to 68.1 mm., males averaging 46.35 mm. in length and females 49.15 mm. Males of 44.0 mm. and over exhibited finger excrescences indicating sexual maturity. About 35 per cent of the specimens taken were under 51 mm. in length.

Bufo fowleri Hinckley

The range of *Bufo fowleri* is statewide. (Brimley, 1926). The species is abundant and generally distributed in Beaufort County but tends to concentrate in foci which are not the same as those occupied by *B. terrestris*. The factors influencing the selection of foci should prove an interesting study. *B. fowleri* is most easily distinguished from *B. terrestris* by means of the cranial crests: the interorbitals are nearly parallel, the postorbitals are longer than in *B. terrestris* and the supratympanic is lacking. In 22 per cent of the specimens taken, the breast is spotted which may also be true in *Bufo terrestris* to the extent of 13 per cent of the specimens taken. The presence of chest spots is an unsatisfactory character for separating *Bufo americanus* in this area. Young *B. fowleri* may be distinguished from adult *B. quercicus* of the same size by means of the parotoid gland, which in the latter extends downward on the side to the level of the center of the tympanum, and by the

presence of many spinose warts in *B. quercicus*. The species was not in evidence and apparently was in hibernation from November 6, 1932, to February 25, 1933: in the colder late winter of 1933–34 the spring appearance was delayed until March 28, 1934. Hibernating individuals were found in rubbish heaps early in January.

Bufo quercicus Holbrook

Brimley (1926) gives Craven, Carteret, Duplin, Edgecombe, Lenoir and New Hanover counties as the known range of *Bufo quercicus* in North Carolina. The writer has taken it in Beaufort and Columbus counties. In Beaufort County, it is abundant within its foci but these are rather widely separated and few in number. The adults of this species may be distinguished from the young of the other members of the genus by means of the greater lateral extension of the parotoid gland, and by the presence of many spinose warts. The earliest record of spring appearance in Beaufort County is of April 30 on which occasion it was found calling at the "*Femoralis* Pond." On the following night the species was present in far greater numbers.

Bufo terrestris Bonnaterre

Brimley (1926) gives the known range of the southern toad in North Carolina as Washington, Jones, Onslow, New Hanover, Cumberland and Scotland counties. The writer has taken the species in the counties of Beaufort, Pitt, Greene, Wilson, Nash, and Columbus. Chest spotting, a character used by Dickerson (1906) and Brimley (1926) to separate *B. americanus*, was found in 13 per cent of the individuals taken. The species was inactive from December 14, 1932, to March 14, 1933, the earliest calling was heard on March 19 and clasping was observed on March 20. Small, shallow pools appeared to be favored as breeding places.

Acris gryllus (Le Conte)

Brimley (1926), gives "eastern district" as the range of *Acris gryllus* in North Carolina. It is very abundant and widely distributed in Beaufort County. It is active throughout the year with the exception of the occasional colder periods in the winter. Calling was earliest heard on January 22. This increased to the proportions of a chorus by March 17. Clasping was first observed on April 19 while the first eggs were procured on April 25.

Acris crepitans Baird

None of this questionable species was found in Beaufort County although Brimley (1926) gives the range in North Carolina as "central and part of eastern districts." The writer has seen individuals commonly in Durham County which are referable to this species. Viosca (1923) has taken considerable interest in the genus, as a result of field observations maintaining that in Louisiana there are two distinct species of *Acris*. The writer is inclined to the view that more field and experimental study are needed to solve the problem. It was observed that in Chases' Lake, Brooksville, Mississippi, only typically *gryllus* forms occur while at Cryme's Pond both forms occur with calls which are recognizably different. The former locality is in a Lafayette Red Clay area while the latter, less than four miles distant, is in a Selma Chalk area.

Pseudacris brimleyi Brandt and Walker

The writer has records of *Pseudacris brimleyi* from Beaufort, Craven, Pitt, Greene, Edgecombe and Wilson counties. The frog is fairly common in Beaufort County and quite generally distributed in the swampy areas. The characteristic ventral spotting and the sharply defined lateral stripe which persist through the various changes of color assumed by the frog are among the characters which easily serve to distinguish this from other species of *Pseudacris* of North Carolina. Walker, who heard the species in northern Georgia, considers the call very similar to that of *Pseudacris brachyphona*. To the writer the call sounds like a rasping trill, "kr-r-r-ak," somewhat less than a second in duration. The note is suggestive of that of *Hyla squirella* but is more strongly accented at the end, and the intervals between the individual notes are shorter. Calling has been heard in rare instances as early as November. Mating takes place early in February and has been observed as late as April 21. Although a wary species, this frog is more frequently found away from dense cover than is *Pseudacris n. nigrita*. The species appears to remain active throughout the winter and retires only with the approach of occasional freezing weather.

Pseudacris nigrita nigrita (Le Conte)

The specimens taken on March 9, 1933, are the first *Pseudacris nigrita nigrita* to be recorded from North Carolina. The closely related *Pseudacris nigrita feriarum* (Baird 1854) is recorded by Brimley (1926) as occurring in Wake, Guilford, Orange and Vance counties. The writer has taken numerous *P. nigrita feriarum* in Durham County. *P. nigrita nigrita* was taken in Beaufort, Columbus, Pitt, Greene, Edgecombe, and Wilson counties. Calling males were heard in Craven County near New Bern. The species is less common and less widely distributed in Beaufort County than is *Pseudacris brimleyi*. The earliest spring record is of February 3. Calls were heard and claspings were recorded from March 10 to April 19 and calls were recorded as late as July 3 in Columbus County. Egg laying was recorded from March 13 to April 20. This frog is shy and difficult to find as it hides with great adeptness. The eggs are light brown above, pale yellow below, being much lighter in color than those of *Pseudacris brimleyi*. One complement of 160 eggs was laid in masses of 75 and less, attached to vegetation below the water surface. Development of the embryos took place at a rate distinctly slower than that for *Pseudacris brimleyi*. Eggs hatch in about 4 days. Mature tadpoles were taken on April 29 at the "*Femoralis* Pond" and transformed individuals were leaving the pond on May 5. Computed from the time of the first observed eggs this indicates a larval period of 53 days. Wright (1931) gives 40–60 days as the larval period.

Pseudacris ocularis (Holbrook)

Brimley (1926) gives the range in North Carolina of *Pseudacris ocularis* as Pitt, Craven and New Hanover counties. Specimens were taken in Beaufort County and calls were recorded in Wilson and Columbus counties. The species is numerous within its foci but its distribution is rather limited. It is the smallest frog of the region, reaching a length of 19 mm. or less. The

breeding males taken averaged 13 mm. and the females 15 mm. in length. The earliest spring record is of February 14, when calling males were heard. Clasping was not observed until March 19; the amplexus is axillary. Eggs were procured on March 20. The breeding activities appear to be confined to shallow, relatively temporary pools, later the frogs may be found about the edges of more permanent ponds and finally they distribute themselves over grassy woodlands. The writer has found them, late in May, in Noxubee County, Mississippi, hopping about in the moist, grassy woods over a hundred yards distant from the nearest body of water. In Columbus County, North Carolina, they were heard calling in flooded grasslands in early July.

Pseudacris ornata (Holbrook)

The individuals taken on February 1, 1933, are the first *Pseudacris ornata* to be recorded from North Carolina. The males were calling and a pair clasped in the laboratory that night. A pair was found clasping in the field on February 7, perched on a sprig of grass some six inches beneath the surface of the water. The clasp is axillary. Infertile eggs were procured on February 10 from a female in the laboratory. The species appears to be quite rare and has not been observed in any other county of the state. Other specimens have been taken on June 1 and November 29. Calls were heard as early as January 10, 1934. The minimum air temperature of the winter of 1932–33, 21° F., occurring on February 6, did not prevent mating on the following night, the minimum air temperature of which was 32° F.

Hyla cinerea cinerea (Schneider)

Brimley (1926) gives the range in North Carolina of the green tree frog as Lenoir, Camden, Craven and New Hanover counties and Cape Hatteras. He later (1927) adds Pamlico County. The writer has specimens from Beaufort and Columbus counties. The species is numerous in its habitat, which appears to be limited to the vicinity of the larger streams and swamps. The earliest spring appearance is recorded on February 25. Calling began on April 29. The latest autumnal record is of December 3.

Hyla crucifer Wied

The range in North Carolina of *Hyla crucifer* is statewide (Brimley 1926). *Hyla crucifer* is abundant and generally distributed in Beaufort County and vicinity. There is no evidence of prolonged hibernation: the species is active throughout the winter at all temperatures above freezing. Breeding activities begin in January and calling may occasionally be heard in December or even in late November. Mated pairs and eggs were taken on January 22 and 23 respectively. Mating continues until March but calls may be heard at the ponds until late in April, when the callers suddenly leave the ponds for the woods. Their departure coincides rather closely with the appearance of later breeders, such as *Bufo quercicus, Hyla femoralis, Hyla gratiosa* and *Rana virgatipes* at the ponds, which is suggestive of an adjustment for the avoidance of competition. The species remains active in the woodlands until their return to the ponds at the time of the next breeding season.

Hyla femoralis Latrielle

The known range in North Carolina of *Hyla femoralis* (Brimley 1926),

includes Craven, Onslow and New Hanover counties. Specimens were taken in Beaufort, Greene and Pitt counties and calls were identified in Columbus County. It is numerous within its foci but these are few and widely separated. The yellow femoral spots, usual brownish hue, and absence of light spots under the eyes distinguishes *Hyla femoralis* readily from *Hyla versicolor*. The earliest spring appearance was recorded on April 16 during a heavy rain. Calls were heard on the afternoon of April 29 emanating from the vicinity of a pine tree near the "*Femoralis* Pond." Many calls were heard after dark. The frogs were well concealed in the grass about the edges of the pond. On April 30 calling was louder and more frogs were in evidence as they became less careful in their concealment. On May 1 the chorus was still louder and a clasping pair was taken. The female laid eggs in the laboratory next morning and within 18 hours the embryos were well formed. Hatching was completed in 1½ days.

Hyla gratiosa Le Conte

The range of *Hyla gratiosa* was extended to include North Carolina in a previous note (Brandt, 1933). It is one of the less common species and is restricted to relatively few localities. The earliest spring appearance on record is of March 23. Calling was heard on April 20 and two mated pairs were taken the same night. Eggs obtained the next morning hatched in three days. A mature tadpole was taken July 1. Calling, clasping, and egg laying have been observed as late as August 7. Some individuals still remained at the breeding places on September 23.

Hyla squirella Latrielle

Craven, Brunswick and New Hanover counties and Cape Hatteras are given by Brimley (1926) as the range of *Hyla squirella* in North Carolina. Specimens were taken in Beaufort and Columbus counties. In Beaufort County it is numerous but restricted to rather few localities. The earliest spring specimen was recorded on April 2. On April 9, sixteen were found hopping about in the damp grass near the bank of Runyon's Creek. Calling was first recorded on May 7. Clasping and egg laying were observed as late as August 7. Active individuals were captured as late as December 7.

Hyla versicolor versicolor (Le Conte)

The range of *Hyla versicolor versicolor* in North Carolina is statewide (Brimley, 1926). The earliest spring appearance recorded was on April 1, at which time the males were heard calling from shrubs at two widely separated ponds. The calling gradually increased in volume with a moderate chorus on April 9 and a strong chorus on April 19. On the latter date clasping was observed, eggs were found on the next day, and a hatching period of 3 days noted. Breeding was still in progress on May 7. The latest active autumnal specimens were taken on December 14.

Rana capito Le Conte

The male captured on the night of March 19, 1933, is the first *Rana capito* on record from North Carolina. The call, resembling a snore, was first heard on the night of March 16. This appears to be the rarest frog of the region, having been observed only a few times in Beaufort County. In Florida, the animal is said to inhabit the burrows of the gopher tortoise,

Gopherus polyphemus. There is no evidence of the occurrence of this tortoise in Beaufort County. Wright (1931) quotes Hallihan who indicates that the gopher frog is not always found associated with gopher tortoises and possibly this species utilizes crayfish burrows as does the closely related *Rana areolata*, as found by Gaige (1914) in Illinois. Large crayfish burrows are common about the pond where the gopher frog has been most often seen.

Rana catesbeiana Shaw

Brimley (1926) gives the range of the bullfrog in North Carolina as statewide. The species is common and generally distributed in the waters of Beaufort County and shows some degree of activity in every month of the year. One precocious individual was heard calling on January 4, 1933. Calling begins in earnest in March and good choruses are under way early in April. On April 25 two males were found in inguinal amplexus. Later on the same night, two other males were found thrashing about in a belly-to-belly clasp. The next night brought forth normal embraces between the sexes and laying of eggs. The amplexus is normally pectoral. The latest record of egg deposition is of May 25. After the breeding season, the bullfrog remains active in ponds and streams and in rainy weather may be found prowling far from permanent water.

Rana clamitans Latrielle

The range of *Rana clamitans* in North Carolina is statewide (Brimley 1926). The species is fairly common in Beaufort County but not as widely distributed as *Rana catesbeiana*. The earliest spring appearance was recorded on April 2; calls were heard on April 8, and active individuals were taken as late as December 28.

Rana palustris Le Conte

Brimley (1926) gives the range of *Rana palustris* as statewide. This frog is fairly common in Beaufort County but limited in distribution to the vicinity of the larger water courses. The earliest spring appearance was recorded on February 25 when it was heard calling at Runyon's Creek. Clasping was observed on March 15. The amplexus is pectoral. Eggs in one large mass were found on March 16. The latest record of active individuals is of December 7. Hibernating individuals have been dug up from the muck in a swamp island of Runyon's Creek in early January.

Rana sphenocephala (Cope)

Brimley (1926) gives the range in North Carolina of the southern leopard-frog as "eastern district." *Rana sphenocephala* is one of the most numerous and widely distributed of the species of the region. There is no evidence of hibernation in this species. Much activity was noticed throughout the winter. Calls were first heard early in January. Clasping and deposition of eggs were observed only in January and February. The amplexus is pectoral. Eggs are laid in submerged masses and were found to hatch in seven days in January but undoubtedly develop more rapidly in warmer months. After the breeding season the frogs scatter throughout the swamps, woods and meadows.

Rana virgatipes Cope

Brimley (1926) gives the range in North Carolina of *Rana virgatipes* as Washington, Moore, Cumberland, Craven, and New Hanover counties. The

writer has taken the species in Beaufort County. It appears to be few in number and restricted in habitat having been found only in a small number of shallow, sphagnaceous pools. The clattering call was heard frequently from April 29 to May 7; during which period ten males were taken but no females were seen.

Microhyla carolinensis (Holbrook)

The range in North Carolina of *Microhyla carolinensis* is given by Brimley (1926) as "eastern district." The species is numerous in Beaufort County and generally distributed in the sandy woodlands.

Males were heard calling on May 8 at the time of the earliest spring appearance. The call resembles the bleat of a kid. They appear to spend much time in the vicinity of the pools probably awaiting favorable conditions of high humidity and heavy rains to begin breeding. On July 3 many were found hidden under pine needles in the vicinity of "low ground." After heavy rains in early August they were in the puddles and ponds, calling and clasping in tremendous numbers. They utilized the edges of permanent ponds as well as the most temporary puddles. Active individuals were taken on the night of November 6.

Summary

Twenty-two species of frogs and toads were found to occur in Beaufort County. One of these is the recently described *Pseudacris brimleyi*. Three others, *Pseudacris n. nigrita*, *P. ornata*, and *Rana capito*, are new records for North Carolina. Extensions of range in North Carolina are reported for *Scaphiopus h. holbrookii*, *Bufo quercicus*, *B. terrestris*, *Hyla c. cinerea*, *H. femoralis*, *H. squirella*, *Pseudacris brimleyi*, *Pseudacris n. nigrita*, *Pseudacris ocularis* and *Rana virgatipes*.

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Two New Subspecies of Mexican Lizards of the Genus *Sceloporus*

By HOBART M. SMITH

THE following descriptions are based upon material collected in 1932 and 1934 in Mexico by Dr. Edward H. Taylor, David H. Dunkle and myself.[1]

Sceloporus jarrovii ***immucronatus***, subsp. n.

Sceloporus torquatus poinsettii ? Boulenger, 1885: 220 (part); ? *idem*, 1897: 481 (part).

HOLOTYPE.—Male, EHT and HMS No. 500, collected 10 miles north of El Pinalito, Hidalgo, Mexico, June 15, 1932.

PARATYPES.—Twenty-two, including eleven collected with the type (EHT and HMS Nos. 498–504, 506–508, 510, 511), and eleven collected about 25 miles south of Jacala, Hidalgo, Mexico, June 16, 1932 (EHT and HMS Nos. 605–615). All collected by Edward H. Taylor and Hobart M. Smith.

DIAGNOSIS.—A species of moderate size belonging to the *torquatus* group; head shields smooth; laterals in diagonal rows, weakly keeled, very weakly mucronate; the median laterals somewhat larger than, to one and one-half times as large as, median dorsals; dorsals in parallel longitudinal rows, very weakly keeled, but slightly mucronate, 37 to 46 from occiput to base of tail; supraoculars usually in two rows, the inner complete, the outer incomplete; canthals regularly two; tibia as long as or slightly longer than shielded part of head; fourth toe from base of fifth slightly longer than distance from snout to posterior margin of ear; ratio of fourth toe to snout-vent measurement, 23.8 to 28.6 (in adults); ratio of hind leg to snout-vent measurement, 64.0 to 71.3; femoral pores 12–19; ground color cobalt blue; collar black, complete, narrow (2 or 3 scales wide), extending across gular fold region in males; region anterior to gular fold and sides of belly cobalt blue; ventral surfaces of limbs and tail glaucous blue or pale blue; median

[1] I am indebted to Dr. Edward H. Taylor for assistance in securing and describing this material; and to Mr. David H. Dunkle of Harvard University, for assistance in collecting. The study involving the description of these species has been forwarded by grants from the University of Kansas Graduate Research Fund.

ventral surface of belly in old males black, the color extending onto proximal portion of ventral surfaces of limbs.

DESCRIPTION OF TYPE.—Dorsal head shields smooth; enlarged supraoculars in two rows, the outer row formed of scales about one-half as large as those of inner row; supraoculars separated from superciliaries by one complete and another incomplete row of scales (the latter present on one side only), and bordered medially by a series of small scales; superciliaries six, the last overlapping the preceding two (the fifth superciliary is entirely overlapped by the fourth); one large, heavily keeled subocular, followed posteriorly by two small, strongly keeled postoculars, these in turn followed by a series of scales passing upward and contacting the parietal; the series of scales between the supraoculars and frontals continued downward between the former series of scales and the margin of the orbit, terminating at about the middle of the posterior postocular; preocular scale strongly keeled, in contact with second canthal and with the rows of scales above supralabials; first canthal in contact with rows of scales above supralabials, separating the loreal from the preocular; about three-fifths of the length of the second canthal forming a part of the superciliary series; rostral about three times as broad as high; two irregular rows of scales above supralabials and in contact with subocular, preocular and subnasal, one row continuous around snout above rostral; interparietal much larger than either parietal, more triangular than pentagonal in shape; a pair of frontoparietals, separated on the median line by the contact of frontal and interparietal; frontal transversely divided; two prefrontals, in contact on median line; three frontoparietals, the lateral in contact with both canthals; three pairs of small internasals, the posterior largest, the anterior smallest; a single small scale, not entering into series surrounding nasal, separates the posterior internasal from the first canthal; five scales, including the subnasal, surround the nasal.

Four supra- and five infralabials to a point below the middle of the eye mental rather U-shaped, its labial border almost equal to that of rostral, mental followed by a series of five or six enlarged scales on each side, the anterior in contact with its fellow on the median ventral line; this series of scales separated from infralabials anteriorly by a single row of elongate scales (except anterior scale, which is in contact with the first infralabial), posteriorly by two rows, the second row beginning below the junction of the second and third infralabials and in contact with the series of postmental scales; scales in temporal region keeled, mucronate in area near ear; anterior margin of ear with five smooth, pointed scales, on one side the upper two much larger than the others, on the other side all five approximately equal in size, the upper two but little larger than the others and smaller than the preceding scales (subequal on one side); lateral cervical pouch present, a fold from about its middle to lower margin of ear; this fold surmounted by scales more strongly mucronate than those adjacent and somewhat smaller than those in region of mandibular symphysis; dorsal scales in parallel or weakly converging rows, very weakly keeled, weakly mucronate; lateral scales more strongly keeled and mucronate, somewhat smaller than dorsals and in diagonal rows; laterals with as many as seven mucrones; dorsal scales a little more than half as large as largest caudals; ventrals relatively

large, about one-half the size of dorsals; breast scales no larger than those in median abdominal area; ventral scales in anterior region, near chin, smaller than gular scales nearer gular fold region; the latter scales as large as those in region of mandibular symphysis; median gular scales about half as large as abdominals; preanals about as large as gulars; ventrals emarginate.

Scales on dorsal surface of upper foreleg somewhat smaller than those on back, those on dorsal surface of lower foreleg considerably smaller; all dorsal scales of arm, except hand, keeled and mucronate; ventral scales of lower forearm somewhat smaller than dorsals of the same member, those on ventral surfaces of upper forearm much smaller; all ventral scales of arm, except hand, smooth; one dorsal, two lateral, and one ventral row of scales around fingers and toes, all continuous to tip except the two laterals, which terminate behind the last scale of the other series; lamellar formula for fingers 9–13–18–19–14.

Dorsal scales of hind limbs keeled, mucronate, less so on foot; dorsals of tibia of about the same size as dorsals on body, those on femur somewhat smaller; ventral scales of hind limb, except foot, smooth; ventrals of tibia somewhat smaller than dorsal scales of the same member; scales on anterior surface of femur smooth, becoming progressively smaller toward the femoral pore series; scales immediately anterior to femoral pore series somewhat smaller than preanals; scales on posterior surface of femur keeled, mucronate, smallest near femoral pores, and becoming progressively larger toward dorsal surface; scales immediately posterior to femoral pore series about one-third to one-half as large as those immediately anterior to pore series; lamellar formula for toes 9–14–20–23–16; a pair of distinctly enlarged postanals; caudals strongly keeled and mucronate except those on ventral surfaces.

General dorsal ground color cobalt blue of varying degrees of brilliancy; this color uniform, without markings, over dorsal surfaces of tail, limbs and back as far forward as neck. A narrow black neck band is present, two or three scales wide, bordered behind and in front by relatively broad pale blue bands about two scales wide; the black collar passes onto shoulder, widens there somewhat, then becomes narrow and completely crosses the gular region. The dorsal surface of the neck and head anterior to the nuchal collar is darker blue (berlin or indigo blue), with irregular pale blue spots. A broad pale blue band begins on the rostral and passes over the supralabials, including the subocular, broadens in the temporal region and passes through the ear, covering the entire opening. This band unites with the light anterior border of the nuchal collar. The area anterior to the gular fold is uniform ultramarine blue; a broad central band down the belly is grayish, with many dark blue edges, which in turn border on lateral lighter blue areas of slightly darker blue than the dorsal ground color. The ventral surfaces of the limbs are light blue, a narrow edge of each scale usually white; the ventral surface of the tail is pale blue, with a suffusion of white in some areas.

VARIATION.—The outer row of enlarged supraoculars (the smaller of the two rows) is frequently fused in part with the inner row, but never is there only a single row. The outer row is formed of scales of varying sizes, sometimes almost as large as the scales of the inner row, sometimes much smaller.

In four specimens the frontal is in contact with the interparietal; in one the two frontoparietals are in contact; in the remainder of the series a single, small, median scale separates the frontal from the interparietal; of the specimens with the latter arrangement, there are three in which the posterior section of the frontal is divided transversely, and the posterior scale of these two is divided longitudinally. In all paratypes the loreal is in contact with the subnasal, the first canthal never (except in holotype) contacting the series of small scales above the supraoculars; the preocular is separated from these latter series of scales in seven specimens; the first canthal is always distinct, never confined to the area above the canthal ridge. The posterior pair of internasals is in contact with the first canthal in three specimens; there are three pairs of internasals, as in the type, in only three paratypes; in nine others there are two distinct pairs, and in the remainder of the series the scales are irregular. The median frontonasal contacts the frontal in one specimen, and is separated from the frontal in another specimen by a small scale intercalated between the two prefrontals.

The two rows of scales between the subocular and superior labials are reduced to one at one point on both sides in nine specimens, on one side in four. The medial of the two rows of scales intercalated between the postmentals and inferior labials extends anteriorly to the anterior half of the second infralabial in one count (two counts per specimen, one on each side); to the middle of the second in one; to the posterior half of the second in five; to the suture between the second and third in twelve; to the anterior half of the third in nineteen; to the middle of the third in one; to the suture between the third and fourth in four; and to the anterior half of the fifth in one.

The dorsal scale rows are distinctly converging in seven specimens. In the remainder they are either parallel or very slightly converging (one row dropping out).

The dorsal coloration of the males is almost identical with that of the holotype. The light borders of the nuchal collar are in some specimens broken; the posterior border may be broken medially, and the anterior may be broken into a series of large light spots. The general bluish coloration of the throat is hardly developed in small specimens, but distinct in those about 70 mm. from snout to vent and larger. The blue of the sides of the belly is continuous with the dorsal and lateral ground color. The neck band is complete around the gular fold region in specimens 70 mm. from snout to vent and larger.

The dorsal coloration of the females is essentially like that of the males. The ground color, however, is grayish instead of blue, and there are present in all but the largest specimens indistinct black spots scattered over the dorsal and lateral surfaces of the body. They are larger on either side of the mid-dorsal line and tend to form two longitudinal rows. The tail is indistinctly banded. The ventral coloration is light, sometimes suffused with bluish in the lateral abdominal regions.

The most characteristic feature of the coloration is the brilliant blue ground color, which is varied only with black. The blue is less distinct in females than in males, but even in these, blue forms an essential element of the coloration.

REMARKS.—*S. j. immucronatus* is most closely related to *cyanogenys* and *minor*. No specimens have been examined which show intergradation with either, however, and it is rather difficult to determine from which it has been derived. I have concluded for the present that *immucronatus* is derived from *minor*. Geographical association points toward such a conclusion, as well as general form, maximum size, character of the preocular and average scale count from occiput to base of tail. It conforms more closely to *cyanogenys* in color, character of the supraoculars and number of femoral pores.

Summarizing the points of distinction between *minor* and *immucronatus*, the following may be mentioned: ratio of hind leg to snout-vent measurement greater in *immucronatus* (64.0 to 71.3, average 66.0, in the latter; in *minor*, 61.2 to 67.5, average 63.4); supraoculars irregular in *immucronatus* (as in *cyanogenys*); femoral pores usually more numerous (rarely more than 14 in *minor*, rarely less in *immucronatus*); enlarged postanals present and well-developed in males of *immucronatus*, variable in *minor*. In color, *immucronatus* differs by having a distinctly narrower black nuchal collar, a general ground color of blue, and much black in the ventral coloration of males.

From *cyanogenys*, *immucronatus* differs in possessing a larger number of scales from occiput to base of tail (37 to 46 in *immucronatus*, 32 to 40 in *cyanogenys*), preocular usually not divided (usually divided in *cyanogenys*), ratio of hind leg to snout-vent measurement greater (58.6 to 66.9, average 64.6), and lesser maximum size (86.0 mm. snout to vent in *immucronatus*, 143 mm. in *cyanogenys*). In color, the males of *immucronatus* differ by having much black in the ventral coloration; *cyanogenys* does not.

MEASUREMENT AND SCALE COUNTS OF *Sceloporus jarrovii immucronatus*

Number	498	500	605	502	508	501	609	610
Snout to vent	87.0	86.0	78.0	75.0	74.5	71.5	67.5	60.0
Tail	143.0	126.0			reg.			90.0
Snout to occiput	16.0	16.5	14.0	14.5	13.8	14.6	12.7	12.0
Snout to ear	20.5	20.0	17.8	18.5	17.5	17.5	15.8	14.5
Hind leg	58.0	56.5	52.0	48.0	48.0	51.0	45.0	42.0
Tibia	17.0	17.0	15.8	14.5	13.9	14.5	13.0	12.0
4th toe	21.0	21.0	19.0	19.0	18.3	20.5	17.0	15.0
5th toe	11.2	11.8	10.2	10.5	10.4	11.0	9.3	8.7
Lamellae 4th toe	23.0	23.0	20.0	20.0	20.0	23.0	19.0	20.0
Femoral pores	16–17	12–14	12–12	16–16	17–17	16– ?	16–16	15–16
Dorsals	43.0	43.0	43.0	46.0	42.0	42.0	40.0	39.0
Ventrals	62.0	54.0	60.0	58.0	55.0	63.0	48.0	52.0
Scales around body	53.0	44.0	43.0	45.0	45.0	50.0	41.0	43.0
Scales to head length	9.0	9.0	8.0	9.5	7.5	10.0	7.5	8.0
Ration hind leg to snout-vent	66.6	65.6	66.6	64.0	64.4	71.3	66.6	70.0
Ration 4th toe to snout-vent	24.1	24.4	24.3	25.3	24.5	28.6	25.1	25.0
Sex	♂	♂	♂	♂	♀	♂	♀	♀

Sceloporus ornatus **caeruleus,** subsp. n.

HOLOTYPE.—Male, D.H.D. and H.M.S. 350, collected five miles south of San Pedro, Coahuila, June 20, 1934.

PARATYPES.—Twelve, all from the type locality (D.H.D. and H.M.S. 348–9, 351–358, 360–1).

DIAGNOSIS.—A member of the *torquatus* group of *Sceloporus;* dorsal scales 47 to 53 from occiput to base of tail; posterior section of frontal reduced or variously divided; supraoculars in two rows, the scales of the outer row somewhat smaller than those of the inner row; lorilabials reduced to one row at a point below subocular; two canthals, normal in position; inner row of labiomentals terminating below third infralabial; femoral pores 12 to 17

(average 13.7); ratio of hind leg to snout-vent measurement, 66.6 to 74.5; ratio of fourth toe to snout-vent measurement 22.7 to 27.4; length of tibia greater than snout-occiput measurement; length of fourth toe usually slightly greater than snout-ear measurement, sometimes equal or slightly less. General ground color bluish; nuchal collar four to six scales wide, light bordered; ventral surfaces of males entirely blue, without darker markings; a series of about seven dark blotches more or less evident on middle of back.

DESCRIPTION OF TYPE.—Head and body somewhat compressed; scales of head not rugose or keeled; scales in prefrontal, frontonasal and internasal regions rather strongly pitted; a few pits on other head scales; parietals single on either side, subtriangular, about one third size of interparietal; interparietal pentagonal, the posterior edge rounded and confluent with posterior edges of parietals; frontoparietals small, square, separated medially by a small azygous scale; another small scale between frontal and right frontoparietal; posterior section of frontal slightly less than one third size of anterior section; prefrontals in contact medially, but slightly smaller than anterior section of frontal; lateral frontonasals subequal in size to prefrontals; median frontonasal somewhat larger; scales in internasal region irregular; nasal small, the anterior border about nostril somewhat wider than posterior border; nasal separated from rostral; supraoculars in two rows, the scales of the outer row about half as large as scales of inner row; one complete and another incomplete row of scales between supraoculars and superciliaries; one row of rather broad scales between supraoculars and median head scales; six superciliaries, the fifth entirely concealed by the fourth, which is abnormally divided into two; two canthals, normal in position, the first somewhat smaller than the second; subnasal smaller than loreal, which is very long and narrow; preocular not divided; subocular followed by two small, well-differentiated, strongly keeled postoculars; lorilabials reduced to one row by two scales below subocular.

Mental subtriangular (tending toward pentagonal), with a labial border slightly more than one half that of rostral; mental followed by about four pairs of postmentals; scales of first pair of postmentals in contact medially; outer row of labiomentals separated from mental by partial contact of first postmental and first infralabial; inner row of labiomentals terminating at a point even with anterior half of third infralabial; median gular scales about one third smaller than lateral gular scales; scales in anterior part of gular area with a terminal pit, those in extreme posterior part of gular area notched.

Auricular lobules three or four, distorted on one side; on the other side the median two are much larger than the outer two, rounded, not keeled, subequal in size to scales in temporal region; scales between ear and lateral nuchal fold one third or one fourth the size of scales in temporal region; latter scales keeled, denticulate, mucronate; a weak skin fold between upper edge of lateral nuchal pocket and lower edge of ear, surmounted by small, very strongly keeled and mucronate scales; median dorsal scales smooth, sometimes rounded, usually with one or two terminal pits or denticulations, rarely with a terminal mucrone; lateral scales somewhat smaller than median dorsal scales, keeled, mucronate, denticulate, with terminal pits; median abdominal scales about one third to one half the size of median dorsal scales,

somewhat larger than preanal scales; scales on chest slightly larger than those in middle of belly; scales on abdomen and on chest smooth, rounded; enlarged postanals present, separated by two scales; subcaudals smooth except toward extreme tip of tail; dorsal caudal scales near base of tail slightly larger than median dorsals on body.

Dorsal scales of foreleg somewhat smaller than dorsal scales on body, keeled, mucronate, with terminal denticulations and pits; scales on lower foreleg somewhat smaller than those on upper; ventral scales of foreleg smooth, notched or with terminal pits, those on lower foreleg somewhat smaller than dorsal scales of same member; ventral scales on upper foreleg about half as large as ventral scales of lower foreleg; lamellar formula for fingers, 10–14–17–18–13 (9–14–18–18–13).

Dorsal scales of hind leg keeled, mucronate, denticulate and with terminal pits; dorsal scales of tibia somewhat larger than dorsals on body, those on femur slightly smaller; ventral scales of hind leg smooth, rounded or notched; ventral scales of shank slightly smaller than dorsal scales of the same member; ventral scales in front of femoral pore series subequal in size to preanal scales, gradually increasing in size toward anterior face of femur; scales on posterior surface of femur strongly keeled, strongly mucronate, slightly larger than preanal scales, abruptly decreasing in size immediately posterior to femoral pore series; no postfemoral dermal pocket; lamellar formula for toes 7–13–17–20–16 (7–13–18–20–16).

MEASUREMENTS AND SCALE COUNTS OF *Sceloporus ornatus caeruleus*

Number	360	361	359	351	349	348	355	354	353	350
Snout to vent	50.2	54.5	57.5	59.0	59.0	62.5	63.0	66.0	66.5	75.0
Tail	81.0				100.0					
Snout to occiput	10.3	11.0	12.0	12.5	12.0	12.0	11.5	12.6	12.5	14.0
Snout to ear	13.0	14.0	15.0	16.0	15.0	16.0	15.0	16.2	16.5	17.5
Hind leg	34.5	39.5	38.5	44.0	44.0	42.0	42.5	44.0	47.0	50.0
Tibia	11.0	12.2	12.5	13.0	12.8	12.0	13.0	13.5	13.0	15.0
4th toe	13.0	14.3	15.5	16.2	15.8	15.9	15.5	15.0	17.0	17.0
5th toe	6.8	7.4	8.1	8.0	8.6	8.2	8.2	7.7	9.0	9.4
Lamellae 4th toe	19–19	19–20	19–18	19–18	20–21	22–20	23–23	19–19	21–21	20–20
Femoral Pores	13–14	14–17	12–13	14–16	14–16	12–14	15–16	13–13	12–13	13–13
Dorsals	52.0	47.0	51.0	51.0	47.0	51.0	53.0	53.0	48.0	48.0
Ventrals	67.0	60.0	63.0	66.0	59.0	58.0	62.0	67.0	61.0	59.0
Scales around body	55.0	47.0	52.0	53.0	50.0	47.0	46.0	54.0	48.0	49.0
Scales to head length	11.0	11.0	11.0	12.0	11.0	9.5	9.5	10.0	10.0	9.5
Ratio hind leg to snout-vent	68.7	72.4	66.9	74.5	74.5	67.2	67.4	66.6	70.6	66.6
Ratio 4th toe to snout-vent	25.8	26.2	26.9	27.4	26.7	25.4	24.6	22.7	25.5	24.3
Sex	♀	♀	♂	♂	♂	♀	♀	♂	♂	♂

General dorsal color pale blue, with a greenish suffusion; a series of large black blotches, about six in number, of indefinite outline, on middle of back, separated from each other by one row of light scales; nuchal collar four scales wide, with light anterior and posterior borders about two scales wide; posterior light border extending onto proximal end of forearm; anterior border terminating on sides of neck slightly above and posterior to lateral nuchal fold; a light bar across neck between ear and foreleg, terminating on sides of neck about at a level with upper edge of ear; an indistinct, broken light line across neck between upper edges of ear; a few light colored scales in temporal region; limbs dimly banded.

Black nuchal collar continuous about neck; a suffusion of black in groin, extending somewhat on ventral surface between groins; entire ventral surfaces

of other parts, including head, limbs and tail, bluish; the sides of the belly, lower surfaces of hind limbs, median gular area and basal region of tail grey smalt blue; lower surfaces of forelegs and distal part of tail suffused with pale blue; median anterior abdominal and anterior gular regions suffused with iridescent apple green; ventral surfaces of hands and feet white.

VARIATION.—The dorsal coloration of all paratypes is much as in the holotype. In females the general ground color is less brilliant. The ventral coloration of the males is much as in the holotype. In younger males the ventral surface of the tail, hind limbs and an indistinct, narrow median area in middle of abdomen are whitish. Females are whitish below, without dark markings, sometimes with a general light suffusion of pale blue.

The parietals are from one third to one sixth the size of the interparietal; the frontoparietals are divided on one side in one, on both sides in another (in the latter specimen, the posterior part of each divided frontoparietal is fused with the interparietal); the frontal touches the interparietal in two; the frontoparietals contact medially in one; an azygous scale lies between the frontoparietals in nine; the posterior section of the frontal is divided into two scales in five specimens; in one the posterior section is absent; in seven the frontal is normally divided, the posterior part always considerably smaller than the anterior; the supraoculars are always in two rows, the scales of the outer row smaller than those of the inner; the row of scales separating the supraoculars from the median scales is always composed of broad, not elongate, scales; all supraoculars separated from median head scales; prefrontals in contact in all; invariably two canthals, normal in position and relationships with other scales; preocular divided in eight; lorilabials reduced to one row at a point below subocular in all; outer row of labiomentals terminating below anterior half of third infralabial in all but two; in one of these it terminates below the posterior half of the third, in the other it terminates below the anterior half of the fourth.

Auricular lobules three to five, usually with two much larger than the others; dorsal scales 47 to 53, average 49.7; femoral pores 12 to 17, average 13.7. Other characters of scutellation approximately as in holotype. Variations in proportions and certain scale characters are given in the accompanying table.

REMARKS.—Specimens of this subspecies were found on large rocks on the north exposure of a range of low, arid hills a short distance north of the road from Torreón to Saltillo, about five miles south and slightly east of San Pedro. Peculiarly enough, the species was not found on a somewhat higher range of hills a short distance south of the road; it is possible that it was not sufficiently warm when Mr. Dunkle and I collected there. It was about 11:00 A.M. when the lizards were encountered in relative abundance. They were extremely wary, and could be collected successfully only by sighting them at considerable distance and then approaching as cautiously as possible. The brilliant ventral coloration of the males was very conspicuous as they protruded their heads and breasts above the edges of rocks.

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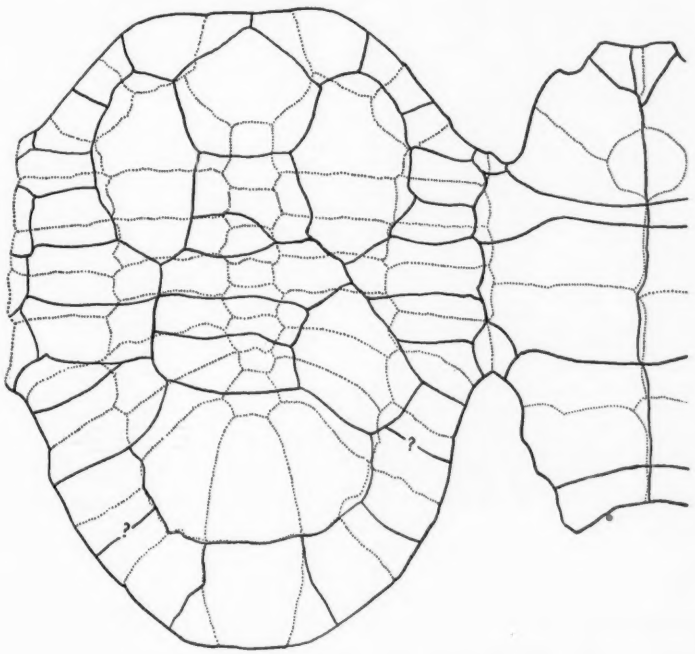
Herpetological Notes

AN EXTRAORDINARY TORTOISE SHELL.—Gadow, Newman and Coker have written extensively on abnormal scute formations in Chelonia, but no such specimen as the one hereafter described is mentioned by any of them or the other casual writers on this subject. Normally there are five neural scutes flanked by four costals on each side. There are often extra neurals or costals which occur more frequently among females, usually towards the posterior part of the carapace. Previously no specimen had come to my attention with a reduced number.[1] The marginal scutes may vary by extra or fewer than the normal number. The scutes of the plastron are much more regular. For instance, among five hundred odd *Gopherus agassizii* (Cooper) only two specimens had extra plastral scutes. The bone plates probably have no correlation with the scutes and are usually normal.

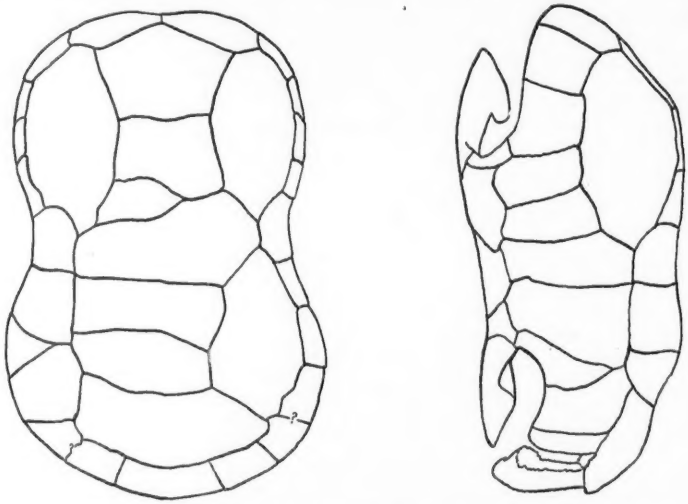


An abnormal specimen of *Testudo tabulata* Walbaum was presented to the writer by Captain T. C. Rose, Public Health Service, at St. Thomas, while on a private herpetological collecting trip through the Virgin Islands from February to May, 1936. The writer presented it to the San Diego Society of Natural History where it is numbered 17047. It measures 11½ inches long, 7 inches wide and 5 inches high. This species was probably introduced into the Antilles and is now feral on some of the islands not infested by the mongoose.

This specimen varies in the most extraordinary manner. The marginals are normal. There are two extra neurals and yet the costals instead of being four on each side are reduced to two on the right side and one on the left. On the right side a neural is in contact with a marginal and on the left this neural and two others impinge on marginals.

[1] Newman, Plate 1, Fig. 7, shows a specimen with the fourth and fifth neurals undivided.

As is to be expected, the plates are normal. The only other case noted of neurals touching marginals is a young specimen of *Chrysemys picta marginata* (Agassiz) in the Museum of the University of Valparaiso, Indiana. This unnumbered specimen has the normal number of scutes, but the fourth neural bears two points which separate the third and fourth costals on each side and barely touch the marginals.



The drawings were made by Mr. Norman Bilderback through the courtesy of Dr. C. G. Abbott of the San Diego Society of Natural History. The solid lines represent the sutures between the scutes and the dotted lines represent the sutures between the plates. At two points question marks are placed on the scutes sutures of the marginals, because a block of bone was missing at these points, but I am fairly certain from extensive observations that the sutures occurred as indicated.

The large diagram is slightly distorted to show all the sutures of scutes and plates. The smaller drawings show a top view without distortion and similarly the left side with its one costal.

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Gadow, Hans. Orthogenetic variation in the shells of Chelonia. *Willey*, 3, 1899.
Newman, H. H. The Significance of scute and plate "abnormalities" in Chelonia. *Univ. of Chicago, Biol. Bul.;* 10, 1906.

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VARIATION IN THE DOTTED BURROWING SNAKE *CHILOMENISCUS STRAMINEUS*.—The dotted burrowing snake, *Chilomeniscus stramineus* (Cope), is one of the small reptiles whose small size and secretive habits along with its restricted geographic range make it poorly represented in collections and little known to zoologists. Therefore it was considered especially good fortune when fifty-one specimens procured at one locality and at nearly one time (Eureka; August 22 to 29, 1929) arrived from Lower California, in the collections obtained by C. C. Lamb, for the Museum of Vertebrate Zoology. Although mention of the lot was made in a report upon the whole collection (Univ. Calif. Publ. Zool., 38, 1932: 345-386), analysis of variation within it was postponed. Recently, I have studied the series in greater detail. Professor F. N. Blanchard examined the specimens in January, 1936, and added some items to the notes I had assembled upon them.

Objectives in studying the variations in this snake were two: first, to determine and re-define the characters of a species previously known from few specimens; second,

to indicate the marked uniformity in this species as compared with other, strikingly variable, members of the genus.

Out of the 51 specimens, 5 were in such condition that the sex could not be determined definitely. The remaining 46 were equally divided, there being 23 males and 23 females. Measurements and scale counts of these are shown in the accompanying tables. The rostral reaches the prefrontals in six individuals, three of each sex. Supralabials are 7—7 in all but two (females) in which they are 7—6. Infralabials are 8—8 in fourteen males and seventeen females; 9—8 in one male; 7—8 in one male and 2 females; 8—7 in five males and two females; 7—7 in two males and two females. Scale rows are 13—12 in nearly all specimens; a few have 14 at the anterior end of the body, and one had only 9 posteriorly.

TABLE 1. Scale characters and measurements, in millimeters, of specimens of *Chilomeniscus stramineus* in Museum of Vertebrate Zoology

	Sex	Rostral reaching prefrontals	Supra-labials	Infra-labials	Scale rows	Gastro-steges	Uro-steges	Body length	Tail length
11875	♂	No	7–7	8–8	13–12	113	29	200	30.4
11855	♂	No	7–7	8–8	13–12	113	32	181	33
11864	♂	No	7–7	8–8	13–12	111	26	178	27.8
11889	♂	Yes	7–7	8–7	13–12	112	29	172	30
11879	♂	No	7–7	8–7	13–12	107	29	172	29.3
11859	♂	Yes	7–7	8–8	13–12	111	30	171.5	27.8
11900	♂	No	7–7	7–7	13–11	107	27	166	27
11885	♂	No	7–7	8–8	13–12	111	30	165	28.4
11897	♂	No	7–7	8–8	13–12	110	30	162	27
11882	♂	No	7–7	8–8	13–12	108	32	161	27.8
11868	♂	No	7–7	8–7	13–11	110	28	161	27.8
11892	♂	No	7–7	8–8	(14)13–12	114	32	160	30
11871	♂	No	7–7	8–8	13–12	112	29	160	26.7
11883	♂	No	7–7	8–8	13–11	107	31	155	28
11887	♂	No	7–7	8–8	13–12	109	27	154	27.8
11895	♂	No	7–7	7–8	13–12	113	31	152	26.9
11884	♂	No	7–7	7–7	13–12	108	29	150	27
11852	♂	Yes	7–7	8–7	13–12	103	27	148.5	22
11858	♂	No	7–7	8–7	13–12	108	28	147.4	24.6
11896	♂	No	7–7	8–8	(14)13–12	107	30	147	27
11872	♂	No	7–7	9–8	13–12	105	28	144	24
11861	♂	No	7–7	8–8	(13)12–9	103	30	99	19.2
11874	♂	No	7–7	8–8	13–12	113	27	96	15.2
11853	♀	No	7–7	8–8	13–12	119	28	215	29
11867	♀	No	7–7	8–8	13–12	118	26	208	30
11890	♀	Yes	7–6	8–8	13–12	121	28	204	30.6
11891	♀	No	7–7	8–8	13–12	120	30	203	27.4
11869	♀	No	7–7	8–8	13–12	119	27	202	28
11862	♀	No	7–7	7–7	13–12	118	29	195	29.6
11880	♀	No	7–6	7–8	13–12	119	27	185	24.8
11873	♀	No	7–7	8–8	13–12	122	26	184	24
11865	♀	No	7–7	8–8	(14)13–13	120	28	184	26.5
11898	♀	Yes	7–7	8–7	13–12	120	25	182	25
11857	♀	No	7–7	8–8	13–12	119	28	177	25
11860	♀	No	7–7	8–8	13–12	113	25	177	23.2
11863	♀	No	7–7	8–8	13–12	112	25	173	22
11893	♀	No	7–7	8–8	13–12	117	28	172	25
11901	♀	No	7–7	8–7	13–12	122	27	166	22
11878	♀	No	7–7	8–8	13–13	115	28	165	27.7
11881	♀	No	7–7	7–8	13–12	111	28	157	21
11866	♀	No	7–7	8–8	13–12	116	27	146	20.6
11899	♀	No	7–7	8–8	13–12	108	29	152	19
11886	♀	No	7–7	8–8	13–12	119	26	142	22
11856	♀	No	7–7	8–8	(14)13–12	119	27	140	20
11894	♀	No	7–7	8–8	13–12	107	24	137	21
11854	♀	Yes	7–7	7–7	13–12	108	25	84	12

It is plain from table 2 that in this snake females are larger than males, but they have shorter tails. This is shown both by measurements and by numbers of scales.

This new lot of material makes it feasible to revise the characterization of the species given by Van Denburgh (Occas. Papers Calif. Acad. Sci., 10, 1922: 874–875). This description is given below with changes as necessitated by the new specimens.

Head rather wide, little distinct from neck. Snout broad, rounded, greatly depressed, pointed in profile. Rostral plate very large, broad, prominent, extensively reverted on upper surface of snout, reaching prefrontals in six out of forty-six examples, bounded behind by the first supralabial and a large plate corresponding to the internasal and

nasals merged. Plates on top of head are the naso-internasals, a pair of prefrontals, a frontal, supraocular on each side, and a pair of rather small parietals. Posterior nasal small, sometimes merged with anterior nasal and internasal. No loreal. One preocular. Two postoculars. Temporals one followed by one or two. Supralabials almost always seven, sometimes six, third and fourth reaching eye. Inferior labials usually eight, sometimes seven, rarely nine, fourth often largest, first pair meeting on median line. Genials in two pairs, posterior much smaller. Scales on body smooth, in 13—12 rows. Anal plate divided. Gastrosteges varying in number from 103 to 122; average 109 in males, 117 in females. Urosteges in two series of from 24 to 32; average 29 in males, 27 in females.

TABLE 2. Summary of scale counts and measurements involved in length of body and tail in *Chilomeniscus stramineus*

		Average	Minimum	Maximum
Gastrosteges	♂	109	103	114
	♀	117	107	122
Urosteges	♂	29	26	32
	♀	27	24	30
Body length	♂	156.6	96	200
	♀	171.7	84	215
Tail length	♂	26.7	15	33
	♀	196	96	244

The top of the head is grayish dotted with brown. The ground color of the upper surfaces of the body and tail in adult specimens varies from brownish drab to bright yellowish cinnamon. It is cream buff in a younger individual. Dark brown spots are present near the tips of the scales in all specimens, but do not appear upon the first row of scales. They are present rarely upon the scales of the second row, but almost constantly upon those of the third. The first, second and half of the third rows of scales are yellowish white or straw-color, as are also the gastrosteges.—JEAN LINSDALE, *Museum of Vertebrate Zoology, University of California, Berkeley, California.*

NOTES ON *AMBYSTOMA GRACILE* BAIRD AND *AMBYSTOMA MACRODACTYLUM* BAIRD.—Descriptions of *Ambystoma gracile* usually give the color of the adults as uniform dark brown above (Slevin, Occ. Pap. Calif. Acad. Sci., 16: 27) or dark chocolate brown on dorsal and upper lateral surfaces (Storer, Univ. Calif. Publ. Zool., 27: 75). On June 1, 1930, a series of this species with yellow dorsal markings was found in a small lake just a little above and to the south of Deer Lake in the Olympic Mountains. Deer Lake is six miles south from Sol Duc Hot Springs and has an elevation of about 5,000 feet. During the night of June 20–21, 1936, Dr. S. C. Bishop, Miss M. Wright and I took a few more specimens of this spotted variety in the same area, so this characteristic must be well established in the heredity of some of the *A. gracile* in the Deer Lake region of the Olympics.

The yellow markings have no definite pattern, are irregular in size and shape, range up to 1 mm. in diameter, and are scattered over the whole dorsal surface, including the head, to halfway down the sides and on the top of the limbs and toes. There are not many middorsal spots and on top of the tail they are very small. Specimens up to 190 mm. in length were found with this abnormal coloration.

On February 23, 1931, Howard Hubbel and I were observing amphibians in a small pond near a street which crosses South Tacoma swamp. The water temperature was 60° C. At this time the salamanders were migrating up the stream. Nearly all of the *Ambystoma gracile* appeared to be gravid females, though only one in ten were transformed adults. No courtship activities were observed. Nearly a hundred bunches of eggs of this species were fastened to the vegetation at the edge of the pond.

A female larva, 140 mm. long, clasped a stem and in sixty-two minutes deposited 45 eggs, progressing only slowly along the stem for about 2 inches during the process, her only visible movement. This probably completed her egg-laying for the year, since no more eggs were deposited after we brought her into the laboratory, nor did she show any signs of transformation after some months of captivity. The eggs developed normally.

The egg masses of *A. gracile* (Fig. 1) are fastened to sticks, such as willow branches or small limbs of fallen trees, from 6 to 24 inches under the surface of the water, in ponds.

If firmer sticks are not available, the heavier grasses and herbs are used. The masses are from 2 to 6 inches long and from 2 to 3 inches thick and contain from 30 to 270 eggs. The outer layer is clear and firmer than any of the amphibian jellies I have seen. The inner envelope is 6 to 7.5 mm. in diameter and the jelly is much less firm. In some preserved egg masses an outer envelope of 11 to 15 mm. in diameter can be observed. The egg itself is 2.5 to 3 mm. in diameter; at the animal pole it is brown to black and at the vegetal pole cream-grey to white.

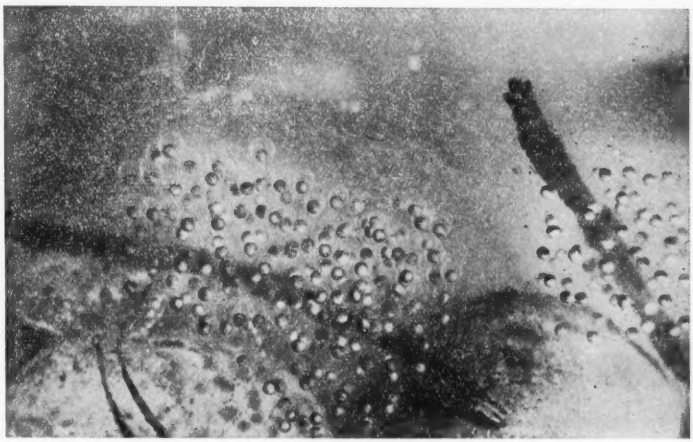

Fig. 1. Egg mass of *Amsbytoma gracile* x 5/6.
(Picture taken in aquarium. Stones used to keep egg mass to glass.)

These eggs are deposited from January to July 20 in this county (Pierce) depending upon the season and the altitude. If the season is warm, they may be found at sea level during the latter part of January and at higher altitudes at later dates until the mountain ponds have thawed, although eggs may be deposited in these ponds while there is still some ice in them. The eggs hatch in two to four weeks, according to weather conditions, and the first year the larvae may grow to 6 inches at lower altitudes and 3 inches in the higher altitudes, where the growing season is only about three months for these animals.

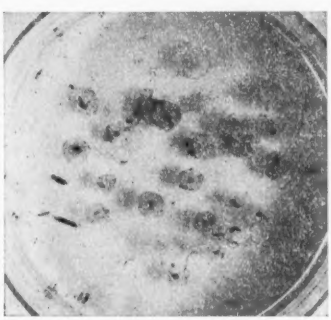

Fig. 2. Eggs and young of *Ambystoma macrodactylum* x ½.

Ambystoma macrodactylum usually deposits its eggs a little earlier than does *A gracile* and prefers even smaller ponds. Here at sea level the difference in time of deposition may be a few weeks while at 5000 feet elevation it is only a few days. If the pond is shallow, the eggs are deposited singly or in bunches up to 10 on the bottom. The salamanders prefer the shallow portions of the pond, and if it is deeper, with no shallow places, the eggs may be fastened to grass hanging in the edge.

The egg of *A. macrodactylum* (Fig. 2) is 2.5 mm. in diameter, black at the animal pole, with the lower two-fifths at the vegetal pole light gray. The two envelopes do not show very clearly; the inner is 6 to 7 mm., and the outer 12 to 17 mm. in diameter, depending on the age of the egg. They hatch in five to fifteen days and may transform at sea level in July, while in the high mountain ponds most of the larvae do not transform

until the beginning of their second year. The size at transformation is 60 to 75 mm.

From a female 127 mm. in length 184 mature eggs were taken.

During courtship the males of *A. macrodactylum* clasp the female just back of the forelimbs and give her peculiar short shakes; the males also clasp small amphibians of other species and shake them.—JAMES R. SLATER, *Department of Biology, College of Puget Sound, Tacoma, Washington.*

NOTES ON THE TURTLES OF LEEDS AND FRONTENAC COUNTIES, ONTARIO.—Leeds and Frontenac counties in Ontario have as their southern boundary the river St. Lawrence and Lake Ontario. Many islands, including the famous Thousand Island group, are scattered through these waters. The islands at the entrance of the river and in Lake Ontario have an underlying rock of limestone, sloping shores, wide marshes and lagoons. The eastern islands from Gananoque to Brockville are of granite and metamorphic rock with abrupt shores and deep water surrounding them. Inland, the country rock is mainly granite which is thrust as a wedge towards the river. The front of this granite block is about twenty miles wide and increases in breadth as it leaves the river. On both sides the limestone overlaps the granite.

Glaciation in this region scooped out many lake basins which are now connected by streams. Since the slope is quite gentle, the highest point in Frontenac is less than 600 feet, with Lake Ontario 250 feet above sea level, the streams are slow and marshes of considerable extent occur. Also, the building of the Rideau Canal about 100 years ago flooded great areas and increased the amount of water in many of the lakes. Conditions such as these are ideal for aquatic life.

The turtles taken in this region were not systematically hunted but are casual specimens picked up in the course of other work over a ten-year period. The soft shelled turtle, *Amyda spinifera,* is unknown to the fishermen who recognize and differentiate between the other kinds. Stejneger and Barbour (1933) give the St. Lawrence and its tributaries as part of the range of this species but the writer has never seen it or heard of it anywhere throughout the region. It is one of the possibilities in future collecting.

Stejneger and Barbour (1933) have been followed in naming the specimens, most of which have been placed in the Royal Ontario Museum of Zoology. Geographical names used are from the maps of the Topographical Survey, Canada. The writer wishes to thank Mr. E. B. Shelley Logier for his assistance and for records from the Royal Ontario Museum of Zoology.

1. *Chelydra serpentina* (Linné).—The snapping turtle grows to a large size in the shallow lakes and rivers of this region. It is probable that specimens could be secured from every lake in both counties. Literature references are few. Toner (1934) mentions the over-wintering eggs of this species collected at Black Rapids, Leeds. Definite locality records are: Long Lake, Verona, Dog Lake, Rideau Canal at Washburn and at Kingston Mills, Cross Lake at Arden, Grippen Lake, Grippen Creek, Charleston Lake, Red Horse Lake, Gananoque Lake, Gananoque River, Higley Lake, Lake Ontario and the St. Lawrence River.

2. *Sternotherus odoratus* (Latreille).—The musk turtle is known to the fishermen as mossback or small snapper. It is found in various lakes throughout both counties. Definite records are: Cross Lake at Arden, Gananoque Lake, Howard Lake and the marshes near Belle Isle, Kingston Harbour.

3. *Emys blandingii* (Holbrook).—The yellow throat of Blanding's turtle is highly diagnostic so that specimens seen by residents are noted as different and most of those I have recorded were given to me. They are usually found wandering on the roads or in the fields. This turtle is not so rare as it is supposed to be. Mr. Logier gave me the following notes for eastern Ontario. "The R.O.M.Z. has two specimens from Prince Edward county, collected in 1928 and 1930, and several sent to us by R. V. Lindsay from Frontenac county in 1932 and 1933. I have a note stating that a specimen was seen in Big Island Marsh, Bay of Quinte, by a Mr. C. Melton about Oct. 1, 1930."

In 1903 two specimens were recorded from Belleville. (The Ottawa Naturalist, XVI: 136). I have definite records from: St. Lawrence River at Gananoque, Gananoque

Lake, two specimens, Howard Lake, two specimens, and Niagara Island, St. Lawrence River.

4. *Graptemys geographica* (Le Sueur).—The map turtle is recorded by Nash (1908) from Lanark County just north of the region studied. There is also an old record for the Ottawa River. This species likes to sun itself on sloping rocks at the edge of deep water, a habit that enables observers to note it frequently. It is common in the lakes and rivers of the county. Occasionally noted in Dog Lake, Cranberry Lake, Charleston Lake, Red Horse Lake, and the St. Lawrence River. Definite records are: Gananoque Lake, three specimens, Howard Lake, and from Float Island, St. Lawrence River.

5. *Chrysemys bellii marginata* (Agassiz).—The painted turtle is very common in every permanent body of water in this region. They may occasionally be found traveling overland during the early summer. Definite records are: Charleston Lake, Jones Creek, Dog Lake, Cross Lake at Arden, Rideau Canal at Washburn, Red Horse Lake, Long Lake at Verona, Cataraqui Creek, St. Lawrence River, Gananoque River, two specimens, Mud Creek, two specimens.

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G. C. TONER, *Gananoque, Ontario.*

NOTES ON THE OCCURRENCE OF *NECTURUS MACULOSUS* (RAFINESQUE) IN MASSACHUSETTS.—*Necturus maculosus* (Rafinesque) is not indicated by Stejneger and Barbour[1] as occurring in New England except in Lake Champlain. During the past five years specimens have been brought to the zoology laboratory of the Massachusetts State College from the Connecticut River, between the towns of Northampton, South Hadley, and Hadley, Massachusetts.

The first specimen to come to my attention was taken at a power substation that is situated at the confluence of the Manhan River with the Connecticut, and was novel enough to attract considerable attention among the inhabitants of this region. This and other occasional specimens were placed on display and excited newspaper comment.

Other specimens have since been brought in from various places in the above-mentioned towns, the latest having been taken at North Hadley, Massachusetts, which is eleven miles up the river from the source of the original capture: one was from South Hadley Falls, six miles downstream from the first locality.

In discussing this situation with people at neighboring colleges, a professor at Amherst College (not engaged in zoological work at present) informed the writer that it was his custom, several years ago, to release at the end of each school year live *N. maculosus* that had previously been purchased from dealers. These were generally loosed in a brook near the Amherst College campus, and such being the case they may have migrated down approximately eight miles of brook (Fort River) to the Connecticut, and spread from the confluence of these two streams eight miles downstream to South Hadley Falls, and nine miles upstream, where the latest specimens were secured.

It is, of course, impossible to say whether or not these releases formed the genesis of the present population. At present *N. maculosus* is well established in this part of the Connecticut River, so well, in fact, that fishermen are beginning to complain about them as being possibly detrimental to game fish. Two other possibilities exist to explain the presence of these forms: (a) they have been present but overlooked, which is highly improbable since this stream has been fished in, studied, and utilized for power or transportation for 250 years; (b) they have migrated in from the Hudson River system, which also seems improbable, because high hills and an intervening watershed (Housatonic River) exist between the Connecticut and Hudson systems.

The presence of these animals in this locality, from artificial sources or otherwise, will probably ultimately result in a greatly extended range, for the tributary system of the Connecticut is quite extensive.—H. E. WARFEL, *Massachusetts State College, Amherst, Massachusetts.*

[1] Stejneger, L. & Barbour, T. 1933. A check List of North American amphibians and reptiles. Cambridge.

Ichthyological Notes

AN OBSERVATION ON SPAWNING BUFFALOFISH IN MISSISSIPPI.[1]—On April 21, 1930, the writer witnessed the spawning activities of a school of black buffalofish, probably *Ictiobus niger* (Rafinesque)[2] along the margin of a cypress–tupelo gum swamp in southern Leflore County, Mississippi. The swamp, locally known as Fowl Brake, was flooded at the time of the observation, and in this condition was connected directly by flood waters with the Yazoo River and several flood-plain lakes.

Fowl Brake, at the site of the observation, is bordered by a ridge of hardwood timber thickly undergrown with bushes several feet in height. During the dry season these bushes chiefly occupy the shore areas of the swamp, as they are distinctly less dense on the area normally covered by water at summer levels. At low-water level, except for scattered holes ranging to 10 or 12 feet deep, the swamp is covered by 2 or 3 feet of stagnant, often scum-coated water. On the occasion recorded, the level was approximately 3 feet above the low-water mark, resulting in the flooding of the bush-grown shore to a depth of 1 to 3 feet.

The spawning buffalofish were first seen about 10 A.M., at which time several hundred individuals had assembled in and around the flooded, bush-grown area adjacent to the swamp. This number did not appear to increase or decrease materially until about 4 P.M., when the school rather abruptly, though quietly, retreated into the deeper waters of the swamp.

As the writer had neither boat nor field glasses at the time of these unexpected observations, the actual mating and egg-laying processes could not be closely observed. No observations of obviously mating pairs were made; in fact, the writer did not recognize at the time that spawning activities were being observed. It was not until 3 days later that the true nature of the incident was made clear.

Although fertilization and egg-laying were not observed, it was recognized that the fish were in a state of excitement. This state seemed to be characterized by movements of repressed eagerness rathr than mad rushes and violent jumping; clearly the fish seemed motivated by a common objective. Most of their movements were near or quite at the surface, and many fish were observed swimming half out of the water. Jumping, when this movement occurred, was a short, arc-like glide, in which the fish seldom cleared the water surface; the resulting disturbance was more of a "plop" in the water than a splash.

Through nearly all of the 6 hours of observation, the spawning fish appeared unconcerned about unusual movements or disturbances or even by the writer's approach on a log to within a dozen yards of their center of activity. It was only toward the end of their spawning process that the fish seemed to recover their normal reaction to alarm, and this recovery gradually became more noticeable as the retreat of the fish into deeper water progressed. Before the last individuals had left the spawning area, many of the fish were observed to dart away at the observer's movements on the log or from such disturbances as caused by sticks being thrown in the water.

At intervals throughout the hours of spawning activity a number of medium-sized alligator gars were observed to range along the margin of the milling fish nearest the deeper waters of the swamp. At times the gars created considerable disturbance by jumping and slashing out after the unwary fish, which, except toward the end of the spawning process, paid no particular attention to their predatory enemies. The writer believes that the gars were attracted by the buffaloes and that, although they probably more commonly feed on game fish, they took an appreciable number of the smaller fish in the school. At least one freshly wounded buffalofish was observed.

As to size, the buffaloes making up the school ranged from 3- and 4-pounders up to individuals weighing at least 20 pounds. The number of very large fish, however, was small as compared to the multitude of average-sized 6 to 10 pound fish. No yearling buffalofish or individuals of other species of the group were observed.

Shortly after 3 P.M. the school began to break up, and the retreating individuals

[1] Published under a grant from the American Wildlife Institute for the publication of contributions fundamental to fish management.

[2] The fish had the appearance of *Ictiobus niger*, a specimen of which was collected in the vicinity the following year.

moved slowly but directly back into deeper water. At 4 P.M. the dispersal was at its height, and a half-hour later the water in the vicinity of the spawning area was quite undisturbed. At no time during the retreat, or afterwards until about 5:30 P.M., were the gars or other predatory fish observed to move into the vacated area.

Three days later, when the writer visited the place again, the water had receded well over a foot. Many fallen tree tops and logs and the lower branches of bushes previously covered by flood water were now exposed, and on these in numerous places were masses of drying spawn. Several masses still half-covered by water were examined. These contained eggs loosely held together by a filmy net of tissue, the strength of which was so slight that the eggs dropped out at every movement. Egg masses that had been exposed to the sun were in various stages of disintegration; many were shriveled and distorted almost beyond recognition. These exposed masses were blackish; those still covered by water were pale green to yellowish green.

From all appearance the decaying spawn attracted a considerable number of carnivorous reptiles, birds and mammals. At the time of the second visit, turtles, crows, blackbirds, hawks and dogs were observed in the immediate vicinity of spawn masses, and all except the several turtles present were observed to feed on the spawn. It is considered likely that the turtles also use the material as food, though probably to a greater degree when the spawn is covered by water than when exposed.

According to the available literature and to professional fishermen who have spent a lifetime in the Mississippi Valley, the spawning of buffalofish as described above may be an unusual observation. During 2 years following the observation, a dozen or more reliable fishermen consulted were able to indicate only 2 parallel instances of buffalofish spawning. One occurred in Mosquito Lake, Leflore County, in 1898; the other in a swamp known as Mossy Lake Brake, also in Leflore County, in 1913, both during the spring season.

Judging from the abundance of buffalofish throughout the lower Mississippi Valley, it may be that the phenomenon recorded here represents an abnormal spawning condition. On the other hand, the paucity of observations of the sort here reported may merely indicate how little is known of the normal spawning behavior of our important fishes.—LEE E. YEAGER, *School of Forestry and Conservation, University of Michigan, Ann Arbor, Michigan.*

NEW CATFISH RECORDS FOR NEW HAMPSHIRE.—Last summer several specimens of the Eastern Madtom, *Schilbeodes insignis* (Richardson), and of the Tadpole Madtom, *Schilbeodes gyrinus* (Mitchill), were taken from the Marrimack River in the vicinity of Concord, New Hampshire. Kendall (1908) did not mention these species in his *Fauna of New England,* and likewise Evermann and Kendall (1896) omitted *Schilbeodes* in their checklist of Vermont fishes. Both species are frequently mentioned in the Biological Survey Reports of the New York Conservation Department but so far as known the specimens taken from the Merrimack represent the only records for New England and consequently northern and eastern stations. Dr. Carl L. Hubbs of the University of Michigan has identified both species. The material of *Schilbeodes insignis* has been placed in the collections of the Boston Society of Natural History and that of *Schilbeodes gyrinus* in the University of Michigan museum. Recently another record of *Schilbeodes gyrinus* has come to light. In Penacook Lake near Concord, New Hampshire, a thriving population of Tadpole Madtoms has been found. The fish are so numerous that they seriously interfere with the use of the lake as a municipal water supply because the small fish often clog the water lines. It is a prevalent opinion that these very small fish are stunted horned pout, and the proposal has been made of introducing them to other ponds where better food conditions prevail. In Penacook Lake the Tadpole Madtom has ruined horned pout fishing because they are far more eager to seize the bait than the desired pout.

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EARL E. HOOVER, *New Hampshire Fish and Game Department, Concord, New Hampshire.*

REVIEWS AND COMMENTS

NEW FISH BOOKS.—Following are reviews or notices of a few of the more important or more usable of recently published books on fishes.

MARINE FISHES OF SOUTHERN CALIFORNIA.. By Percy Spencer Barnhart. University of California Press, Berkeley, California, 1936: i–iv, 1–209, 1 diagr., figs. 1–290. Cloth, $4.00.—Twenty-three years ago, the reviewer, then a very raw-boned undergraduate not yet out of his 'teens, sought out the author of this book, who at the time was director of a little public aquarium on an amusement pier near Los Angeles, operated in part as a biological laboratory of the University of Southern California. He wished to discuss the identification and data of a very rare eel that he saw preserved and displayed in the aquarium, and to ask for permission to include the new record in a forthcoming paper on the fishes of California. The kind granting of this somewhat surprising request was the first of a long series of like favors given the reviewer and other ichthyologists. Such discoveries by the author, largely reported by others, have constituted a very considerable contribution to Western ichthyology.

Barnhart had already made considerable progress in 1913 on a list of the fishes of Southern California, paying particular emphasis to reproductive behavior. A few years ago he contributed some very interesting results of studies on the breeding habits of various species, and now publishes his *Marine Fishes of Southern California,* the first complete handbook to the rich fish fauna of the region. This book gives a list with brief diagnoses of 370 fishes which have been recorded from the bays and ocean between Point Conception and the Mexican border, with figures of 288 species. The briefly monographic treatment provides a book of great value to the general public and to ichthyologists, particularly those who do not have available or have not analyzed the greatly scattered mass of scientific information that is here so conveniently summarized. The diagnoses which have largely been abstracted from "Jordan and Evermann" and other works, give as usual only typical counts and measurements and a few other characters, but are generally quite sufficient for the ready identification of specimens from the region treated. The numerous figures were drawn with no inconsiderable artistic skill by the author, at the approximate size of reproduction. Hence they are often a little deficient in detail. Since many were traced from previously published figures, greater accuracy and economy could have been obtained by borrowing the copied cuts, but the very pleasing uniformity of the figures, which are grouped together at the end of the work, would then not have been attained. The figures, made from stippled drawings, are vastly more usable than the outline sketches used in many recent manuals of this sort. Brief natural history notes on many species add interest and value to the treatise.

Despite much revising, a number of confusing errors remain, some of which may be mentioned for annotation by users of this manual. Figs. 100 and 101, and 120 and 121, are transposed. Species of *Trachipterus* are entered under 2 families. *Gasterosteus aculaetus* [sic] is listed and figured on the basis of a subspecies not occurring in Southern California. The numerous species of the *Sebastodes* group are wisely kept in the one genus, but the key is not as thoroughly refined as it could have been and some species names are in the neuter gender. The distributional limits of some species, for instance *Ilypnus gilberti,* are not stated as now known. Girard is misprinted Gilbert in the rather extensive bibliography.

As an example of printer's art, this book is a model, in paper, format and topography. It is well provided with service sections—analytical Contents, Introduction, Notes on the Descriptions of Fishes, Glossary, Bibliography and a vernacular and a Latin index.

SALAR THE SALMON. By Henry Williamson. Little, Brown and Co., Boston, 1936: 1–301, 32 illustr. $2.50.—In the opinion of the reviewer, this dramatization of the life of the Atlantic Salmon is better done than Roule's: the author is less given to unrestrained exuberance (in Anglo-Saxon judgment), and has no pet theories to ride. The

story of the salmon is told with rare literary skill, and is cleverly interwoven with a very human tale of the struggles between the many local poachers and the water "bailies" of the local Conservancy Board. The reviewer wonders whether this narrative account of the salmon's life, thus foiled by human contacts, might not have been so portrayed by this skillful writer as to lose little if any of its popular appeal, without recourse to the personifying of the principal fish characters. In some of the most vivid passages, the ways of the fish are indeed described and narrated with no attempt to humanize the salmon and trout. The prosaic ichthyologist, interested in the accurate popularization of his science, must regard as unnecessary, silly and harmful such extremes of personification as the love plot, running intermittently through the book and culminating in the ecstatic mating on the headwater redds, between Salar and his young and comely mate, the female grilse, Gralaks. The great educational value of this book is somewhat lessened by a score or more of such zoological misstatements as these: Salar absorbed oxygen through his gill-rakers and sensed dangers with 2 lateral lines on each side; the old seal sought out the cave of his birth in which to die, and Garbargee, the conger, fed off the corpse of a sea cow that had drifted 2000 miles in the Gulf Stream, and barnacles laid their eggs on wood. As a whole, however, the life of the salmon is truly as well as vividly portrayed. The book is likely to be finished at one reading.

FREMDLÄNDISCHE SÜSSWASSERFISCHE. By Joh. Paul Arnold and Ernst Ahl. Gustav Wenzel & Sohn, Braunschweig, 1936: 1–592, 7 half-tone pls. and 749 figs. 32 R. M.—This book is written by 2 of Germany's leading aquarists, one of whom is also very active in the systematic study of aquarium fishes. It attempts to list all of the freshwater fishes from foreign lands that have been introduced alive into Germany. Most of the species are described, with particular reference to color, size and sexual differences, and figured from drawings or photographs, of very unequal accuracy. A few words are usually given on date of first introduction and on aquarium culture, and breeding habits as observed in aquaria are frequently recorded. The general introduction covers only 6 pages. The arrangement, probably convenient for aquarists, is systematic to families, alphabetical by scientific name within families; synonyms and bookish German names are also given. The last 8 pages are devoted to cultivated varieties. Species of the United States are as a rule very poorly and in part unrecognizably figured and described—for which we can partly blame American aquarists, who generally regard our own native fishes, no matter how attractive, as unworthy. This new addition to the already extensive library of aquarium books will appeal chiefly to expert aquarists and to ichthyologists.

AQUARIA AND GARDEN PONDS. By W. Harold Cotton. A. and C. Black, Ltd., London, 1935: i–vi, 1–90, 32 figs. and 10 pls. (2 col.). Price in United States, $1.35 (The Macmillan Co., agents).—If the aquarium fish hobby is waning, as many hold, the decline is not reflected in the output of books for fish fanciers. Mr. Cotton, who entered what he terms the fancy-fishkeeping hobby through microscopy, has contributed a book that is different from most other recent ones, especially in that it entirely avoids the "tropicals." Designed for beginners, it deals in an elementary way with the principles of fishkeeping; with garden ponds, aquaria and aquiaries (the author's name for an outside fish house, for which construction plans are given), and with cold-water aquarium fishes, and their pests and diseases. The book though written for English readers is largely applicable to American conditions. The text is very readable, well popularized and generally sound, though marred occasionally by minor misstatements, mostly zoological.

CARL L. HUBBS, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

THE MARINE FISHES OF WEST AFRICA. By Henry W. Fowler. Bull. Am. Mus. Nat. Hist., 70, 1936, pts. 1 and 2, 1493 pp., colored frontispiece and 567 text fig. $5.00 and $7.00.—This is a comprehensive, systematic review of the fishes of the eastern tropical Atlantic, with a compilation of the references to them in the vast, scattered literature. It lists some 1100 species, and comprises descriptions and keys for the determination of species, genera and higher groups, while attractive, mostly outline figures executed by the author illustrate many of the forms treated. As there was previously no comprehensive work on West African marine fishes, this will simplify greatly the task of determining material from these waters. It should become one of the invaluable text books to which we are constantly referring, a basis on which to build further knowledge mark-

ing a step forward in our understanding of the world's fish faunas.

The fishes in this area have been less carefully studied than in many others, and the time when one may rule finally on their nomenclature and synonymy is not yet. The author has used his judgment freely in such matters, and the field he covers here being too wide for solution of the many problems involved, various of his rulings may only be considered authoritative in so far as there is no further definite information available. This will make the work none the less useful or the less a monument to the wide knowledge and indefatigable industry of the author, without which it would not have been possible.—J. T. NICHOLS, *American Museum, New York City.*

A TAXONOMIC STUDY OF THE COSMOPOLITAN SCINCOID LIZARDS OF THE GENUS EUMECES WITH AN ACCOUNT OF THE DISTRIBUTIONAL RELATIONSHIPS OF ITS SPECIES. By Edward H. Taylor. Kansas Univ. Sci. Bull., 23: 1–643, 84 figs., 43 pls.—Taylor's monograph of the genus *Eumeces* has been long awaited, and the appearance of the fat volume in which it is embodied is a notable event in herpetological circles. This reviewer has some personal interest in this work, since it was certain specimens of *Eumeces,* collected in northwestern Louisiana, which led him to introduce himself in 1916 to Miss Mary C. Dickerson, at the American Museum of Natural History, with the request for permission to examine the collections of *Eumeces.* It was a memorable day, for Miss Dickerson took him to lunch with another young herpetologist, Emmett Reid Dunn, whose first field trip under museum auspices was just being arranged by herself. Since that time, as Dr. Dunn has written, much water has flowed under many bridges. The writer's interest in the genus *Eumeces* was swamped by other interests and duties, and, with the exception of an examination of the Chinese species in 1923, and a successful day's collecting of *Eumeces septentrionalis* in Wisconsin with one of the best of field naturalists, his late brother, F. J. W. Schmidt, he has not returned to its study.

The framework of plan and definition set up by Taylor for his revision, and his definition of the genus, are admirable. He demonstrates that the groups of species discernible within it are not sufficiently distinguished to fall into any clear subgeneric classification. The general discussion of anatomy, habits, ecology, phylogeny, and distribution occupies only thirty-seven pages out of more than 600. This is disappointingly brief, until, on further examination of the work, it is learned how many species are known from museum specimens only, and how much remains to be learned about the ecology of even the best known forms.

The taxonomy of the genus composes the major part of the work. This seems to be extremely satisfactory treatment, species by species, setting forth diagnostic characters, detailed description, relations to other species, and distribution by both map and locality list. At the present stage of our knowledge, except as noted below, the writer is in agreement with Dr. Taylor in his tendency to "split," rather than to "lump." For the better known forms the distribution maps present a nearly complete picture of the range. One must admit the justice of Mr. Parker's remark that such maps, for the rarer forms, exhibit the distribution of herpetologists in time and space rather than the distribution of the species in question, but even these afford clues to faunal relations which cannot otherwise be expressed. As is the case with all such taxonomic work, the present paper will make possible great extensions of our knowledge of the distribution of these lizards, and a secure taxonomic foundation for detailed observations of habits and ecology can not fail to stimulate observation in these fields also.

The reasons for the distinction of *Eumeces laticeps* from *Eumeces fasciatus,* proposed by Taylor in 1932, are now set forth in detail. This seems to the reviewer still not completely proven. There is a discrepancy in Illinois between the map and locality lists for *laticeps.* The general coincidence in the range of the two forms is great; the failure of *fasciatus* to reach the *"laticeps"* size at the north conforms with the distribution of size within widespread species of reptiles; and the principal scale character cited, the arrangement of the temporal scales, might be suspected of some alteration with the widening of the head in adult males, while the difference in post-labials may be an alternative character. Against this must be set, in addition to Taylor's conclusion, based on so great a material, the findings of Noble and Mason, who report a larger egg size and

more rapid growth in *laticeps*, which can only be explained, if the species is *not* distinct, by the assumption that these differences are due to the larger size of the mother. Further work, however, should clarify the status of *laticeps* beyond question.

The remaining points in which the writer is not in agreement with Taylor are minor. The "origin" of the genus, hypothetical at best, is placed in eastern North America; the writer would prefer to leave "North America" unrestricted. The otherwise excellent description of the skull and skeleton might well have included a more detailed comparison with *Mabuya*. In matters of form, he does not like the capitalization of specific names; the locality records on maps can be more exactly placed by means of circles or other open figures than with the use of solid spots; he has a deep seated prejudice against the word "entity" as applied to a genus; and the title is unduly long.

In conclusion it must be stated that any review of a study of this nature can have but little significance. The real test of "Taylor's *Eumeces*," as this work will long be known, will come with its use on the laboratory tables of herpetologists.—KARL P. SCHMIDT, *Field Museum of Natural History, Chicago, Illinois.*

A KEY TO THE RATTLESNAKES WITH SUMMARY OF CHARACTERISTICS. By Lawrence M. Klauber. Trans. San Diego Soc. Nat. Hist., 1936, 8 (20): 185–276, figs. 1–112. Unquestionably the most important contribution to the study of North American poisonous snakes since Stejneger's work of 1895, this paper summarizes present knowledge of the systematics, biology and distribution of the rattlesnakes and presents a reliable key for their identification. From a careful study of over 8000 specimens, forty valid species and subspecies (thirty-four in the genus *Crotalus* and six in *Sistrurus*) are recognized. Four notable changes in current nomenclature have been necessary: (1) the substitution of *Crotalus cinereous* Le Conte in Hallowell, 1852, for *C. atrox* Baird and Girard, 1853; (2) *C. viridis* Rafinesque, 1818, for *C. confluentus* Say, 1823; (3) *C. durissus* Linnaeus, 1758, for *C. terrificus* Laurenti, 1768, (as the specific name of the neotropical rattlesnake relegating *terrificus* to subspecific status for the South American form); and (4) the use of *tergeminus* Say, 1823, instead of *edwardsii* Baird and Girard, 1853, for the western subspecies of the massasauga. By reason of his own studies not yet published on this group, the reviewer is in complete agreement with these changes.

In a succinct review of the bionomics of the rattlesnakes are discussed such topics as habitats, economic status, habits, food, size, reproduction, control, enemies, commercial uses, senses, rattles, fangs, venoms, and the treatment of snake bites. Preceeding the key proper is a very complete glossary defining descriptive terms and followed by illustrations of those peculiar to the rattlesnakes. Additional line drawings clarify the terminology of important characters at various intervals throughout the key.

The key is in dichotomous form in which the selection is consecutively limited to one of successive pairs of alternatives. The characters employed are most carefully chosen and in practically every case several are used in combination so that, even in this highly variable group in which aberrations are frequent and there is considerable overlap in the individual characters of closely related forms, anyone using the key properly should meet with few serious obstacles in the accurate determination of the specimens in hand. Under each species and subspecies the known range is stated in considerable detail. Following the key are nine maps, in which by various types of shading the range of each form is indicated, and thirty-eight photographs from life illustrating all but six of the forty species and subspecies. The index is a convenient tabulation by means of which one can quickly find references in the key, definitions of the ranges, maps and illustrations of each form.

Mr. Klauber's well-known lucid style and painstaking care in explaining all technical details makes the key useable by anyone interested in natural history. Since this paper is at present the only inclusive work embodying the results of recent investigations on the rattlesnakes, it will be indispensable to herpetologists.—HOWARD K. GLOYD, *Chicago Academy of Sciences, Chicago, Illinois.*

EDITORIAL NOTES AND NEWS

Meetings and Conferences

THE second AMERICAN WILDLIFE CONFERENCE is to be held at St. Louis on March 1 to 4, with headquarters at Hotel Jefferson. Technical sessions on fisheries problems are being planned.

The LIMNOLOGICAL SOCIETY OF AMERICA is holding its second annual meeting at Atlantic City, in conjunction with the meetings of the American Association for the Advancement of Science. Two general sessions are being held, for the presentation of limnological papers from the membership at large.

The annual meeting of the AMERICAN FISHERIES SOCIETY held at Grand Rapids, Michigan, on September 2–4, was again notable for the large number of technical contributions to economic ichthyology. The next meeting of the Society is to be held in Mexico City, on August 23 to 25.

Ichthyologists and Fish Managers

LIONEL WALFORD, who has joined the scientific staff of the U. S. Bureau of Fisheries, is at present located at the Biological Laboratories at Harvard University, but expects soon to go to New Orleans on the shrimp investigation. His book on the game fishes of western Mexico is to appear soon.

LAWRENCE F. MILLER of the University of Illinois has accepted a position as Assistant Aquatic Biologist in the Biological Readjustment unit of the Tennessee Valley Authority. He will be concerned with fisheries research and development.

Science News tells of the discovery of abundant fossils of fishes of Tertiary age in Alaska, by Dr. ERICH MAREN SCHLAIKJER of Brooklyn College. These are to be studied at the American Museum.

ALFRED MCLAREN WHITE, who had risen rapidly in the teaching profession of mechanical engineering but maintained his early interest in ichthyology and continued to cooperate with the University of Michigan Museum of Zoology, died on September 23 in New York City, at the age of 32. An obituary notice appeared in *Science* for December 11.

RAY SCHRENKEISEN, of the technical staff of *Field and Stream* died on July 6. We are told that the handbook of North American fresh-water fishes which he had in preparation is being completed by John T. Nichols and Francesca LaMonte of the American Museum.

Herpetological News Notes

DR. and MRS. WILLIAM MANN will lead a zoological expedition soon to Sumatra, Ceram and other Asiatic lands, to collect reptiles, amphibians and fishes as well as higher vertebrates.

The Zoological Society of Philadelphia will send ROGER CONANT to Europe early in January to make a study of the outstanding zoological gardens. Mr. Conant plans to visit Hamburg, Berlin, Munich, Paris, Antwerp, Amsterdam and London.

Financial assistance for the publication of this issue of COPEIA has been received from MAJOR CHAPMAN GRANT and PROFESSOR JAMES R. SLATER as well as the AMERICAN WILDLIFE INSTITUTE.

Western Division

IN the absence of Prof. Arthur Svihla, now on a trip around the world, the duties of Secretary-Treasurer of the Western Division of our Society have been assigned by President Bolin to Dr. George S. Myers, Stanford University, California.

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